Course Code	21ASP302L	21AIP302L	21AUP302L	21BTP302L	21BMP302L	21CHP302L	21CEP302L	21CSP302L	Course Name	PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP302L	21EEP302L	21EVP302L	21EIP302L	21FPP302L	21MEP302L	21MHP302L	21NTP302L						0	0	6	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	learn responsible and professional way of working
CLR-2:	practice development-oriented approach to work
CLR-3:	enhance students' knowledge in one particular technology
CLR-4:	create awareness of the social, cultural, global and environmental responsibility as an engineer
CLR-5:	grow more empathetic, become systems thinkers, become explorers, problem-solvers

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	develop capability to acquire and apply fundamental principles of engineering	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-2:	become updated with all the latest changes in technological world	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-3:	make deep connections between ideas	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-4:	learn to take creative risks	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-5:	be ready for the creative economy also engage in iterative thinking and divergent thinking	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-

The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.
Project Work Selection: Students shall form into either Intra-Departmental or Inter-Departmental teams and undertake a project during VI semester in their Programme Specific Area. Each team will be mentored by a faculty member and monitored through periodical reviews by the Project Review Committee / Panel. A report needs to be submitted upon completion of the project work, which will be assessed by the TWO internal examiners appointed by the head of the department.

	Continuous Learning Assessment (100% weightage)				Final Examination (0%)
	Review - 1	Review - 2	Project Report	Viva-Voce	
Project	30 %	40%	10 %	20 %	-

Course Code	21ASP401L	21AIP401L	21AUP401L	21BTP401L	21BMP401L	21CHP401L	21CEP401L	21CSP401L	Course Name	MAJOR PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP401L	21EEP401L	21EVP401L	21EIP401L	21FPP401L	21MEP401L	21MHP401L	21NTP401L						0	0	30	15

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	learn responsible and professional way of working
CLR-2:	practice development-oriented approach to work
CLR-3:	enhance students' knowledge in one particular technology
CLR-4:	create awareness of the social, cultural, global and environmental responsibility as an engineer
CLR-5:	grow more empathetic, become systems thinkers, become explorers, problem-solvers

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	develop capability to acquire and apply fundamental principles of engineering	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-2:	become updated with all the latest changes in technological world	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-3:	make deep connections between ideas	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-4:	learn to take creative risks	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-
CO-5:	be ready for the creative economy also engage in iterative thinking and divergent thinking	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-

The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability, and sustainability.

(i) *The students shall form into either Intra-Departmental or Inter-Departmental teams and undertake a Major Project in their Programme Specific Area during Eighth semester, duly approved by the Department Project Review Committee / Panel, The Major Project can be carried out either:*
- *a) in any of the Funded Projects / Research Centres / Incubation Centres within SRMIST [or]*
- *b) within any laboratories of College of Engineering and Technology [or]*
- *c) in an Industry / Research Centre outside SRMIST / Startups duly approved by the Department Project Review Committee / Panel.*

(ii) *Each team will be mentored by a faculty member and monitored through periodical reviews by the Project Review Committee / Panel.*

(iii) *After completion of the Major Project Work, the student team shall submit a Report/Dissertation/Thesis, and undergo the due process of assessment by ONE External and ONE Internal Examiner recommended by the head of the department and duly approved by the CoE, for successful completion of the Major Project*

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project	10 %	20 %	30 %	10 %	30 %

Course Code	21CHS251T	Course Name	BASIC CHEMICAL ENGINEERING	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	describe the basic principles of process calculation
CLR-2:	explain the concepts of Stoichiometry equations and material balances
CLR-3:	demonstrate the behavior of fluids and fluid flow phenomena
CLR-4:	describe the principles of filtration, working of filtration equipment's and concept of agitation
CLR-5:	illustrate the basic concepts and laws of thermodynamics

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	perform unit conversions and stoichiometric calculations	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	interpret material balance for non-reactive unit operations	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	apply fluid properties, continuity and Bernoulli equation for fluid flow	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	formulate the concepts of filtration and agitation in processes	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	comprehend the basic concepts and laws of thermodynamics for different processes	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamental Concepts of Stoichiometry — **9 Hour**

Concept of units and dimensions, system of units, unit conversions, basis of calculation, concept of mole, expressing composition of mixture of solids, liquids and gases - percentage by weight, mole and volume and density calculation, concentrations - molality, molarity, normality, ppm, predicting P-V-T properties of gases using ideal gas law

Unit-2 - Material Balance in Unit Operations — **9 Hour**

Introduction to material balance, material balance for non-reactive chemical process systems - Mixing, Drying, Crystallization, Extraction, Chemical reactions and stoichiometric equations - limiting reactant, excess reactant, conversion, degree of completion, selectivity and yield, concept of recycle, purge and bypass stream

Unit-3 - Fluid Flow Phenomena — **9 Hour**

Fluid, properties of fluids, type of fluids and flow, Fluid statics - hydrostatic equilibrium, Pressure measurement by manometers - simple U-tube, differential U-tube, inclined differential manometers, Reynolds number, continuity equation, Bernoulli equation

Unit-4 - Filtration and Agitation — **9 Hour**

Concept of Filtration, Filter media, filter aid, principles of cake filtration, pressure drop through filter cake, Compressible and incompressible filter cakes, filter medium resistance, Constant pressure filtration, constant rate filtration, Filtration equipment's - principle and working of filter press, Vacuum leaf filter, rotary drum filters. Introduction to agitation, agitation equipment, impeller, turbines, flow patterns, prevention of swirling, draft tubes

Unit-5 - Basic Concepts in Thermodynamics — **9 Hour**

Chemical Engineering Thermodynamics- System, surrounding, boundary, Work, Energy, Heat, Internal energy, Intensive and Extensive properties, State and path functions, processes and its type, equilibrium, enthalpy. Heat capacity- derivation for constant volume and constant pressure processes. First Law of Thermodynamics-Mathematical statement, sign convention, problems, Limitations of First Law of Thermodynamics, Energy balance for closed system. statement of second law of thermodynamics, concept of entropy, Third law of thermodynamics

Learning Resources

1. Himmelblau D.H. and James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall, 2012
2. Bhatt, B.I. and Thakore S.M., Stoichiometry, 5th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2010
3. Warren L. McCabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edn., McGraw Hill Education (India) Edition, 2022
4. Noel de Nevers, Fluid Mechanics for Chemical Engineers, 2nd ed., McGraw Hill International Editions, 1991
5. Smith, J.M., Van Ness, H.C., Abbott, M.M., Introduction to Chemical Engineering Thermodynamics, 8 th ed., McGraw Hill International Edition, 2018

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) – Formative CLA-1 Average of unit test (50%)		Continuous Learning Assessment (CLA) – Life-Long Learning CLA-2 (10%)		Summative Final Examination (40% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr. S. Kiruthika, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. E. Poonguzhali, SRMIST

Course Code	21CHS252J	Course Name	CHEMICAL ENGINEERING PRINCIPLES	Course Category	S	ENGINEERING SCIENCE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	describe the various modes of heat transfer and evaluate the rate of steady state heat transfer
CLR-2:	explain and analyze the basic concepts of convection as applied to various flows and geometry
CLR-3:	illustrate principles of mass transfer, Diffusion phenomena, and calculate mass transfer rates
CLR-4:	elucidate the principles of drying, different types of drier and calculate drying time for different drying periods
CLR-5:	demonstrate the concept of distillation, extraction and adsorption

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	analyze steady state heat conduction and calculate the rate of heat transfer	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply the basic concepts of convection and calculate the heat transfer coefficient	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	interpret mass transfer principles and solve diffusion problems	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	calculate drying time for different periods of drying	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	comprehend the various types of distillation, extraction and adsorption for different processes	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Conduction — **15 Hour**

Introduction to various modes of heat transfer, Concept of rate of heat transfer, heat flux, conduction, Fourier's law of heat conduction, Thermal conductivity, Steady state heat conduction through plane wall, composite wall, hollow cylinder, coaxial cylinders

Unit-2 - Convection and Heat Exchangers — **15 Hour**

Concept of heat transfer by convection, Newton's law of cooling, Natural and forced convection- Dimensional analysis- Empirical correlations, Heat exchange equipment, Parallel and counter flow, LMTD, heat transfer area

Unit-3 - Mass Transfer and Diffusion — **15 Hour**

Introduction to Mass Transfer, Diffusion, Types, Fick's law of Diffusion, Molecular diffusion in gases: steady state diffusion of A through non-diffusing B, Gas phase equimolal counter diffusion, Diffusion in Multicomponent gas mixtures, Molecular diffusion in liquids: steady state diffusion of A through non-diffusing B, Liquid phase equimolal counter diffusion, Effect of temperature and pressure on diffusivity

Unit-4 - Drying — **15 Hour**

Drying - Importance of drying in processes, principles of drying, wet Basis, dry basis, Free moisture, equilibrium moisture, bound and unbound moisture, Mechanism of drying, drying curve, Calculation of drying time under constant drying conditions: constant rate and falling rate period, Total drying time, Classification of dryers, solids handling in dryers, tray, rotary, spray and fluidized bed drier

Unit-5 - Distillation, Leaching and Adsorption — **15 Hour**

Introduction to Distillation, principle, Raoult's law, relative volatility, Types of distillation, batch distillation - Rayleigh's equation, flash and steam distillation, General principles of extraction, choice of solvent, mixer-settler, Introduction to leaching, adsorption – isotherm

Practice

Practice 1: Heat transfer through composite wall	Practice 8: Estimation of Diffusivity
Practice 2: Heat Transfer through composite lagged pipe	Practice 9: Drying characteristics
Practice 3: Heat transfer by natural convection	Practice 10: Batch distillation
Practice 4: Heat transfer by forced convection	Practice 11: Steam distillation
Practice 5: Stefan-Boltzmann apparatus	Practice 12: Single stage leaching
Practice 6: Double pipe heat exchanger	Practice 13: Multi stage leaching
Practice 7: Shell and tube heat exchanger	Practice 14: Soxhlet Extractor
	Practice 15: Adsorption

Learning Resources

1. Robert E. Treybal, "Mass-Transfer Operations", 3rd Edn., McGraw Hill Education (India) Edition, 2012.
2. Warren L. McCabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edn, McGraw Hill Education (India) Edition, 2022.
3. Christie John Geankoplis, "Transport Processes and Separation Process Principles (Includes Unit Operations)", 4thEdn, Pearson India Education Services Pvt. Ltd., 2015.
4. Binay K. Dutta, "Principles of Mass transfer and Separation Processes", Prentice- Hall of India, New Delhi, 2016.
5. N. Anantharaman and K. M. Meera Sheriffa Begum, "Mass Transfer Theory and Practice", Prentice Hall of India Pvt. Ltd., New Delhi, 2017.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr.S. Kiruthika, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. E. Poonguzhali, SRMIST

Course Code	21BTC201L	Course Name	BIOCHEMISTRY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the preparation of laboratory reagents with competence and proficiency
CLR-2:	analyze the different forms of carbohydrates in samples qualitatively using different chemical tests
CLR-3:	determine the types of fatty acids, and use a variety of tests and reagents
CLR-4:	become familiar with chromatographic methods and use them to isolate and characterize various biological substances
CLR-5:	recognize the fundamentals of various reagents and how they interact with biomolecules for measurement

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	perform basic professional skills related to solutions, pH, and buffer preparation, as well as numerical calculations, focusing on the laboratory	3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	identify the various ways in which different types of carbohydrates respond to chemical tests	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	explain how various chemicals interact with fatty acids to determine the distinct types	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4:	develop methods for separating and detecting amino acids	3	3	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-5:	describe the measurement of biomolecules in clinical and dietary samples	-	3	-	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Basics of Analytical Biochemistry — **12 Hour**

Practice:

1. Stoichiometric calculations – Molecular weight calculation, Molarity, Normality, Molality, % solution, w/w, v/w, v/v, etc.
2. Verifying the influence of H+ and OH- ions in the test solutions by pH meter.
3. Preparation of biological buffers.

Unit-2 - Qualitative Analysis of Biomolecules - Carbohydrates — **12 Hour**

Practice:

1. Differentiate between aldose and ketose sugars with standards and natural food samples.
2. Identify whether the given sugar is pentose/reducing sugar or not with standards and food samples.
3. Distinguishes between mono or disaccharides also to check to reduce or non-reducing disaccharides with standards and food samples such as milk, malted sugars, and sugarcane juice/Jaggery.

Unit-3 - Qualitative Analysis of Biomolecules- Carbohydrates, Fatty Acids /Lipids — **12 Hour**

Practice:

1. Verifying the given carbohydrate is starch – polysaccharide.
2. Qualitative analysis of fatty acids and cooking oils/fish oils.

Unit-4 - Separation of Biomolecules and Quantitative Analysis of Biomolecules — **12 Hour**

Practice:

1. Separation of amino acids from the mixture and boiled legumes as test samples by TLC and detection by using ninhydrin solution.
2. Estimation of reducing sugar-glucose from the blood by 3, 5-Dinitrosalicylic acid (DNS) method.

Unit-5 - Quantitative Analysis of Biomolecules — **12 Hour**

Practice:

1. Estimation of protein from food samples by Lowry's method.
2. Quantification of cholesterol from egg yolk by Zak's method.

Learning Resources

1. Biochemistry Practical Manual - 2023.
2. Varley's Practical Clinical Biochemistry by Gowenlock A.H., 6th Edition, 2022 (8th Reprint), ISBN: 9788123904276, CBS Publishers & Distributors.
3. Principles and Techniques of Practical Biochemistry (5th Ed.).Wilson, K., Walker, J. (eds.); Cambridge University Press, Cambridge, 2000, 784 pp., ISBN 0-521-65873-X.
4. An Introduction to practical biochemistry (2nd edition): By David T. Plummer. Pp 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978. https://doi.org/10.1016/0307-4412(78)90089-4

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr. Pachiappan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. S Subashini, SRMIST

Course Code	21BTC202T	Course Name	MICROBIOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	introduce the concept of Microbiology and Microorganisms
CLR-2:	understand the growth, metabolism and adaptation of bacteria
CLR-3:	illustrate the structure and life cycle of eukaryotes
CLR-4:	illustrate the structure and life cycle of viruses
CLR-5:	analyze the applications of Microbiology in various fields

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	illustrate the structure of prokaryotes	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	understanding the growth of prokaryotes	2	2	2	-	2	-	-	-	-	-	-	-	2	-	-
CO-3:	explain the growth and life cycle of microbial eukaryotes	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-4:	discuss the life cycle and pathogenicity of viruses	3	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	discuss the role of microbes and microbial products in various fields	3	2	2	-	3	-	-	-	-	-	-	-	3	-	-

Unit-1 - Microscopy and Structure of Prokaryotes — **9 Hour**

Introduction to Microbiology. Characterization, Classification and Identification of microbes. Microscopy - Light, Electron and Advanced Microscopy. Structure of prokaryotes - Bacteria, Mycoplasma. Morphology, Structure, Cultivation, Reproduction and Pathogenicity of Actinomycetes

Unit-2 - Metabolism and Adaptation of Prokaryotes — **9 Hour**

Metabolism of Prokaryotes: Bacteria - Growth curve and kinetics. Quantification of bacterial growth. Microbial metabolism: Non-biosynthetic and biosynthetic pathway. Adaptation mechanism of Halophiles, Alkaliphiles, Psychrophiles, Piezophiles, Xerophiles. Bacterial Recombination: Transformation, Transduction, Conjugation

Unit-3 - Eukaryotes Structure and Methods of Microbial Control — **9 Hour**

Structure of eukaryotes: Fungi, Algae and Protozoa - Characteristics, Morphology, Reproduction, Physiology and Pathogenicity. Control of Microorganisms: Physical Control and Chemical Control. Antibiotics

Unit-4 - Structure of Virus — **9 Hour**

Virus: Morphology, Structure, Classification and Pathogenicity. Bacteriophages: Lytic and Lysogenic life cycle of bacteriophages. Animal viruses, Plant viruses and Oncoviruses. Plaque assay.

Unit-5 - Applications of Microbiology — **9 Hour**

Applications of Microbiology: Soil Microbiology - Microbial Interactions, Biogeochemical roles of Microbes.Aquatic Microbiology - Waste water treatment.Agricultural Microbiology - Biofertilizers. Environmental Microbiology - Bioremediation, Bioplastics, Biopolymers. Industrial Microbiology - Microbial metabolites. Medical Microbiology - Antibiotics and Vaccines

Learning Resources

1. Pelczar MJ, Chan ECS and Krein NR: Microbiology, Mc Graw Hill, 10 th Edition, 2016.
2. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley and David A. Stahl: Brock Biology of Microorganisms, Pearson. 15 th Edition, 2017.
3. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: Prescott, Harley and Klein's Microbiology, Mc Graw Hill, International Edition, 10 th Edition, 2016.
4. Jawetz, MA Brooks, GF Butel JS and Morse SA: Medical Microbiology, Mc Graw Hill, 26 th Edition, 2012.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr. J. Lavanya, SRMIST.
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. R. Muthukumar, SRMIST.

Course Code	21BTC203L	Course Name	CELL AND MICROBIOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	provide basic differences between prokaryotic and eukaryotic organisms
CLR-2:	understand the different strategies of organization of cellular structures
CLR-3:	provide hands on training in isolation of cells and cell organelles
CLR-4:	focus on the cellular response to stimulus
CLR-5:	comprehend the mechanism of bacterial pathogenesis

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	distinguish between prokaryotic and eukaryotic cells using microscopic analysis	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	gain proficiency in identifying the cellular structures	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3
CO-3:	acquire skills to isolate cells and cell organelles and relate with cell division	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	critique the cell's response to stimuli thereby correlating cell signaling	-	-	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-5:	integrate cell biology & microbiology to understand the bacterial pathogenesis in host	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Distinguish Between Prokaryotic and Eukaryotic Cells — **12 Hour**

Practice:

1. Microscopic observation of cells: Simple staining & Cross section of plant & animal tissues
2. Biochemical characterization of bacteria - IMVIC tests
3. Specific enzyme assays and substrate hydrolysis for bacterial identification

Unit-2 - Visualization of Cellular Structures Using Differential Staining — **12 Hour**

Practice:

1. Cell wall staining – Gram staining/ Lactophenol cotton blue staining of fungi
2. Nuclear staining of cells using Giemsa
3. Bacterial Spore staining.

Unit-3 - Isolation of Cells/Cell Organelles and Cell Division — **12 Hour**

Practice:

1. Isolation of bacteria by pour plate/spread plate and culturing techniques (Streak, Slant & Deep).
2. Isolation of Chloroplast from leaves and determination of chlorophyll content
3. Mitosis cell division in vegetative cells

Unit-4 - Response of Cell to Stimuli — **12 Hour**

Practice:

1. Stomatal movement in response to stimulus
2. Bacterial motility using hanging drop technique
3. Determination of cell viability using tryphan blue

Unit-5 - Understand the Mechanism of Bacterial Pathogenesis — **12 Hour**

Practice:

1. Bacterial Growth curve
2. Antibiotic sensitivity tests using Kirby Bauer assay
3. Adherence of Enteropathogenic E.coli on host cells.

Learning Resources	
	1. Lab manual 2. Chaitanya, k. V. Cell and molecular biology: A Lab Manual. India, PHI Learning, 2013.
	3. Lorrence H. Green, Emanuel Goldman. Practical Handbook of Microbiology: Fourth Edition, CRC Press. Taylor and Francis; 2021. 4. Julio E.Cellis. Cell Biology: A Laboratory Handbook. (2008). United Kingdom: Academic Press

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr.S.Sujatha, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr.J.Lavanya, SRMIST

Course Code	21BTC204T	Course Name	BIOPROCESS PRINCIPLES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	describe the basics of the fermentation process
CLR-2:	explain the process of media formulation and sterilization kinetics
CLR-3:	study the basics of reactor design and its control systems
CLR-4:	analyze the metabolic stoichiometry and energetics of the biochemical process
CLR-5:	illuminate the various types of reactors for suspension and immobilized cell systems

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the basics of the fermentation process	1	-	2	-	-	-	-	-	-	-	-	-	2	2	2
CO-2:	comprehend the process of media formulation and sterilization kinetics	2	2	2	2	2	-	-	-	-	-	-	-	-	2	1
CO-3:	acquire the basics of reactor design and its control systems	2	-	2	1	2	-	-	-	-	-	-	-	2	2	1
CO-4:	evaluate the metabolic stoichiometry and energetics of the biochemical process	2	3	1	2	-	-	-	-	-	-	-	-	2	-	-
CO-5:	explore the various types of reactors for suspension and immobilized cell systems	3	-	2	2	-	-	-	-	-	-	-	-	2	2	2

Unit-1 - Microbial Cell Factories — **9 Hour**

Cellular systems as molecular factories and its industrial importance, Isolation and improvement of industrially important organisms, Types of fermentation, Upstream and downstream bioprocess, Process flow sheets of primary and secondary metabolites production- eg. ethanol, lactic acid, lysine, poly-L-lactic acid, lipase, rhamnolipid, streptomycin, insulin, Interferon, monoclonal antibody, tumour necrosis factor inhibitor, Pneumococcal conjugate vaccine.

Unit-2 - Design and Preparation of Media for Bioprocess — **9 Hour**

Bioreaction theory, Kinetics of biological systems, Growth patterns and kinetics of cells, Quantifying cell growth kinetic parameters, Optimization of cell growth environment, Types of media and classes of medium components. Media formulation and optimization of medium for the industrially important cultures - Microbial, plant and animal cells, Sterilization, Types of sterilization - batch, continuous and air sterilization

Unit-3 - Bioprocess Design - Instrumentation and Control Systems — **9 Hour**

Fermentation facility, equipment and space requirements - Fermenter design and its configuration, Body construction, Agitators, Stirrer glands and bearings, Spargers and valves, Aseptic operation and containment, Bioinstrumentation and its control - Methods of measuring process variables, Online analysis of chemical factors, Control systems, Combination of methods of the controller, Troubleshooting in a fermentation plant.

Unit-4 - Fundamentals of Biological Engineering — **9 Hour**

Material and energy balances for reactive and non-reactive systems; Stoichiometry of growth and product formation; Degree of reduction, electron balance and theoretical oxygen demand, Determination of stoichiometric coefficients, Theoretical prediction of yield coefficients, Conductive and convective heat transfer; Overall heat transfer coefficient, Bio-thermodynamics.

Unit-5 - Bioreactors for Suspension and Immobilized Cultures — **9 Hour**

Strategies for choosing a bioreactor, Microbial and immobilized cell system, Active and passive immobilization of Cells, novel reactors - Airlift Bioreactor, Fluidized Bed Bioreactor, Membrane Bioreactor, Photobioreactor, Biofilm reactor, Single-use bioreactors, Various modes of operation in Bioreactors, Performance equation of a batch, fed-batch and continuous reactors, Stability analysis of bioreactor.

Learning Resources	1. Pauline M. Doran "Bioprocess Engineering Principles", 2nd Edition, Academic Press, 2012. 2. Michael L. Shuler, Fikret Kargi, Matthew DeLisa "Bioprocess Engineering: Basic Concepts", 3rd Edition, Prentice-Hall, 2017.	3. Hall, Stephen J., Stanbury, Peter F., Whitaker, Allan, "Principles of Fermentation Technology", 3rd Edition, Butterworth– Heinemann, 2017.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., Chennai., sam@orchidpharma.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr. V. Vinoth Kumar, SRMIST
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. P. Radha, SRMIST

Course Code	21BTC205L	Course Name	BIOPROCESS PRINCIPLES LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	describe the basics of the fermentation process
CLR-2:	explain the process of media formulation and sterilization kinetics
CLR-3:	study the basics of reactor design and its control systems
CLR-4:	analyze the metabolic stoichiometry and energetics of the biochemical process
CLR-5:	illuminate the various types of reactors for suspension and immobilized cell systems

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the basics of the fermentation process	1	-	2	-	-	-	-	-	-	-	-	-	2	2	2
CO-2:	comprehend the process of media formulation and sterilization kinetics	2	2	2	2	2	-	-	-	-	-	-	-	-	2	1
CO-3:	acquire the basics of reactor design and its control systems	2	-	2	1	2	-	-	-	-	-	-	-	2	2	1
CO-4:	evaluate the metabolic stoichiometry and energetics of the biochemical process	3	3	1	2	-	-	-	-	-	-	-	-	2	-	-
CO-5:	explore the various types of reactors for suspension and immobilized cell systems	3	-	2	2	3	-	-	-	-	-	-	-	2	2	2

Unit-1 - Microbial Cell Factories	12 Hour
Practice:	
1. Estimation of glucose by DNS assay method	
2. Production of enzymes by solid state fermentation	
3. Production of enzymes by submerged fermentation	
4. Effect of pH and temperature on enzyme activity	
Unit-2 - Design and Preparation of Media for Bioprocess	**12 Hour**
Practice:	
1. Batch sterilization kinetics	
2. Measurements of Cell Biomass Concentration	
3. Medium optimization by Plackett - Burman design	
Unit-3 - Bioprocess Design - Instrumentation and Control Systems	**12 Hour**
Practice:	
1. Fermenter operation – Demonstration/Explanation	
2. Methods of measuring process variables during yeast fermentation in fermenter	

Unit-4 - Fundamentals of Biological Engineering	12 Hour
Practice:	
1. Microbial growth kinetics to determine the doubling time	
2. Microbial growth kinetics to determine the yield coefficient	
3. Enzyme kinetics – Michaelis Menten Kinetics and Lineweaver Burk – Plot	
Unit-5 - Bioreactors for Suspension and Immobilized Cultures	**12 Hour**
Practice:	
1. Preparation of immobilized cells/ enzyme	
2. Enzyme immobilization kinetics	
3. Production of ethanol by yeast	

Learning Resources	1. Debabrata Das, Debayan Das," Biochemical Engineering- A Laboratory Manual" Jenny Stanford Publishing, 2021.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai.sam@orchidpharma.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr.M.Venkatesh Prabhu, SRMIST
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. Vinoth kumar, SRMIST

Course Code	21BTC206T	Course Name	GENETICS AND CYTOGENETICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	describe the fundamental Laws of Genetics and interaction of genes
CLR-2:	explain the concepts and experiments in the preparation of linkage map
CLR-3:	describe the elements of Genetic Counseling
CLR-4:	analyze gene transfer and its role in mapping in bacteria
CLR-5:	differentiate factors that lead to genetic variation in a population

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	analyze the pattern of inheritance of genes and its interaction	2	2	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-2:	construct linkage maps from inheritance pattern of different genes	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-3:	illustrate the role of Genetic Counselor and techniques in genetic testing	3	2	2	3	-	-	-	-	-	-	-	-	3	-	-
CO-4:	illustrate gene mapping based on the type of recombination in Bacteria	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO-5:	analyze genetic variations in a population	2	2	-	2	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Pattern of Inheritance and Gene Interaction — **9 Hour**

Mendel's Experiments - Law of segregation, Law of independent assortment - Problems in Mendelian inheritance; Allelic interaction -Lethal genes, Non-allelic interaction – Epistasis, Duplicate genes, Complementary and inhibitory genes; Multiple allelism –ABO, Rh factor in Humans; Cytoplasmic inheritance; Mechanisms of sex determination and sex linked inheritance; Epigenetics - histone modification, methylation - x-inactivation, dosage compensation, Lyon hypothesis

Unit-2 - Linkage and Chromosome Mapping — **9 Hour**

Chromosome structure, Chromosome organization, Giant chromosomes - polytene chromosome, Lampbrush chromosome; Linkage - Arrangement and types of linkage; Crossing over - Frequency of recombination, Cytological basis of crossing over - Stern's experiment; Chromosome mapping - Mapping by two factor cross, Mapping by three factor cross, Interference and Coincidence, Solving Problems, Combining of map segments, Preparation of linkage map; Somatic cell hybridization - HAT selection procedure

Unit-3 - Basic Human Genetics — **9 Hour**

Mutation - classification, structural chromosomal aberration - deletion, duplication-tandem and dispersed repeats, inversion, translocation; Numerical aberration; Genetic counseling – History and pedigree construction – Autosomal and X-linked, Diagnosis - Human karyotype preparation, FACS, FISH, Counseling, Follow-up - Prenatal diagnosis – amniocentesis, chorionic villus sampling; Multifactorial inheritance – congenital malformation, diabetes, comparative genome hybridization

Unit-4 - Bacterial Genetics — **9 Hour**

Bacterial genetics, Mechanisms of recombination, Transformation in bacteria - Mapping by transformation, Recombination by generalized transduction - Mapping by generalized transduction, Specialized transduction by lambda phage - Mapping by specialized transduction; Recombination by conjugation - Mapping by Interrupted mating analysis, Preparation of linkage map in bacteria, Fine structure mapping by Merozygote analysis

Unit-5 - Population Genetics — **9 Hour**

Population genetics, Allele frequency - Calculation of allele frequency in a population, Calculation of genotype frequency - Hardy-Weinberg equilibrium, Applications of Hardy Weinberg equilibrium; Changes in allele frequency - Changes in allele frequency by mutation, changes in allele frequency by migration - migration dynamics, changes in allele frequency by selection - selection dynamics, Random genetic drift - Loss of heterozygotes, Genetic equilibrium

Learning Resources

1. *Gardner, Simmons, Sunstad, "Principles of Genetics," 8 th edition – John Wiley and Sons, Inc., 2006.*
2. *Monroe W. Strickberger, "Genetics," 3 rd edition – Phi Learning, 2015*
3. *Peter Sunstad and Michael Simmons "Principles of Genetics" 7th edition, Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. S. Barathi, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. K.T. Ramya Devi, SRMIST

Course Code	21BTC207T	Course Name	MOLECULAR BIOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Biotechnology*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the structures of nucleic acids and their role as hereditary materials*
CLR-2:	*adopt the structure of nucleic acids for their expression and regulation*
CLR-3:	*explain the basis and mechanism of protein synthesis and activity*
CLR-4:	*understand the regulatory role of nucleic acids in cell functioning*
CLR-5:	*scrutinize the controlling events of gene expression under anabolic and catabolic conditions*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*reminisce the structure of nucleic acids at the DNA and RNA levels*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*	*3*
CO-2:	*comprehend the analysis of functioning of nucleic acids*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*relate the expression of DNA at the different levels*	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-4:	*assess the mechanisms of protein synthesis with the genetic code*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-5:	*invoke the various regulatory elements and mechanisms controlling gene expression*	*3*	*2*	*2*	*1*	-	-	-	-	-	-	-	-	-	*3*	*3*

Unit-1 - Structure and Composition of Nucleic Acids	***9 Hour***
Genetic information and its perpetuation; Development of molecular biology; History of nucleic acids; Landmark experiments of DNA as the genetic material; Modes of DNA replication; DNA constituents; DNA structure and its stability; DNA models; A-, B- and Z-DNA forms; Central dogma; DNA topology	
Unit-2 - Replication and Repair of DNA	***9 Hour***
Basic rules for replication; Chemistry of DNA synthesis; Types and the mechanisms of DNA replication; Replication enzymes; DNA polymerases in prokaryotic and eukaryotic replications; Proof reading activity of DNA polymerase; Topoisomerases; Events in the replication fork; Models of DNA replication; DNA repair mechanism	
Unit-3 - Transcription and Post Transcription	***9 Hour***
Basic features of RNA synthesis; RNA polymerases; Types and function of RNA polymerases; DNA promoters- structure and function; Epigenetics Fundamentals; RNA transcription; Transcription of mRNA, rRNA, and tRNA genes; RNA processing; Posttranscriptional modifications of mRNAs; RNA editing-RNAi and miRNAs	
Unit-4 - Translation and Post Translation	***9 Hour***
Coding of genetic information; Outline of translation; Translation in prokaryotes and eukaryotes; Polyribosome; Posttranslational modifications; Protein folding and sorting; Protein targeting into mitochondria and nucleus;	
Unit-5 - Gene Regulation	***9 hour***
General aspects of Regulation; Gene regulators; Silencers and Enhancers; Operons; Positive and negative gene regulations; The operon models; Lac, Trp, Ara and Gal operons and their regulations	

Learning Resources	1. *Robert Weaver, Molecular Biology, McGraw-Hill, 2011*	2. *James D Watson, Molecular Biology of Gene, Pearson Publisher, 2017*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr. Aravind Rengan, Indian Institute of Technology Hyderabad. aravind@bme.iith.ac.in*	1. *Dr. N. Selvamurugan, SRMIST*
2. *Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com*	2. *Dr. K. Subramanian, Indian Institute of Technology Madras. subbu@iitm.ac.in*	2. *Dr. S. Barathi, SRMIST*

Course Code	21BTC208L	Course Name	MOLECULAR BIOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the genetic material as DNA in prokaryotes
CLR-2:	evaluation of the DNA in prokaryotes
CLR-3:	understand the extrachromosomal element and gene transcripts in prokaryotes
CLR-4:	dissection of extrachromosomal element and gene transcripts
CLR-5:	know DNA damage in prokaryotes

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	reminisce genetic materials in unicellular organisms	-	3	-	-	-	-	-	-	-	-	-	-	-	2	3
CO-2:	comprehend the isolation and characterization of genetic materials	3	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO-3:	retrospect the genetic materials at different levels	3	-	1	-	-	-	-	-	-	-	-	-	-	3	3
CO-4:	relate the co-existence of these materials	3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO-5:	invoke the genetic defect causing cell death	3	3	3	-	-	-	-	-	-	-	-	-	-	3	3

Unit-1 - Genomic DNA Isolation and Analysis	12 Hour
Practice: 1. Isolation of Genomic DNA from E.coli 2. Quantitative Analysis of Genomic DNA 3. Qualitative Analysis Genomic DNA	
Unit-2 - Plasmid DNA Isolation and Analysis	**12 Hour**
Practice: 1. Isolation of Plasmid DNA from E.coli 2. Quantitative Analysis of Plasmid DNA 3. Qualitative Analysis of Plasmid DNA	
Unit-3 - Total RNA Isolation and Analysis	**12 Hour**
Practice: 1. Isolation of Total RNA from E.coli 2. Quantitative Analysis of Total RNA 3. Qualitative Analysis of Total RNA	

Unit-4 - DNA Cloning Enzymes	12 Hour
Practice: 1. Restriction Enzyme Digestion of DNA 2. Ligation of DNA Fragment into Plasmid 3. E.coli Transformation	
Unit-5 - DNA Damage	**12 Hour**
Practice: 1. Effect of UV radiation on Bacterial Growth	

Learning Resources	1. Molecular Cloning, A Laboratory Manual by M. R. Green and J. Sambrook, 2012, Cold Spring Harbor Laboratory Press	2. Molecular Biology Techniques, A Classroom Laboratory Manual, 2019, Elsevier Press

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	1. Dr. K. Subramanian, Indian Institute of Technology Madras. subbu@iitm.ac.in	1. Dr. N. Selvamurugan, SRMIST
2. Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	2. Dr. Sudha Warrier, Professor and Dean, Manipal University, sudha.warrier@mannipal.edu	2. Dr. S. Barathi, SRMIST

Course Code	21BTC209T	Course Name	BIOPROCESS ENGINEERING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	enumerate the Ideal and Non- Ideal Reactors
CLR-2:	discuss the fluid flow and its mixing in the reactor
CLR-3:	explain the mass and heat transfer in the reactor, and scale up in Bioreactor
CLR-4:	describe the structured and unstructured models of microbial system
CLR-5:	discuss modern tools in Bioprocess Engineering

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the ideal and non-ideal systems in bioprocess engineering	3	3	3	-		-	-	-	-	-	-	-	1	-	-
CO-2:	gain knowledge on fluid flow and its mixing property	3	2	1	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	acquire knowledge in transport phenomena and scale up studies	3	2	1	1	-	-	-	-	-	-	-	-	2	2	2
CO-4:	understand structured and Unstructured models	2	1	3	1	-	-	-	-	-	-	-	-	2	-	-
CO-5:	apply modern tools in modelling of bioprocess system	1	1	3	3	3	-	-	-	-	-	-	-	2	2	-

Unit-1 - Ideal and Non- Ideal Bioreactors — **9 Hour**

Ideal Batch, Fed-Batch, Continuous, Enzymatic catalyzed reaction in CSTR, CSTR with Recycle, Ideal Plug flow reactor. Reactors with Nonideal mixing-mixing times in RTD, Models for Non-ideal reactors-Tanks in Series Model- Dispersion models.

Unit-2 - Fluid Flow and Mixing in Bioreactors — **9 Hour**

Classification in fluids, Reynolds Number, Viscosity, Momentum Transfer, Non-Newtonian fluid, Rheological Properties of Fermentation Broths, Factors Affecting Broth Viscosity, Mixing- Power Requirements for Mixing- Scale-Up of Mixing Systems- Improving Mixing in Fermenters- Effect of Rheological Properties on Mixing- Role of Shear in Stirred Fermenters

Unit-3 - Transport Phenomena and Scaleup in Bioreactors — **9 Hour**

Gas liquid mass transfer in cellular systems, Determination of Oxygen Transfer Rates, Forced Convection mass transfer, Correlation for Mass Transfer Coefficients, and Interfacial areas. Heat Transfer correlations. Scale up concerns in Microbial, Mammalian and plant cell Process-Scale up criteria-Selection of scaleup criteria-scaleup of genetically engineered cell culture fermentation.

Unit-4 - Models in Bioprocess — **9 Hour**

Model classification- Model Formulation- Unstructured Models- Phases of batch growth cycles-Monod Models-Multiple substrate models and model Inhibition, Models of growth and non-growth product inhibition, Models for the growth of fungi, Plant cell and Animal cells, Structured models- Models of metabolites and growth-compartmental Models-Models of product formation.

Unit-5 - Modelling and Simulation in Bioprocessing — **9 Hour**

Introduction to modelling and Simulation. Modelling and simulation of Batch, Fed-Batch and Continuous system using MATLAB. Artificial Intelligence and Machine Learning in bioprocessing. Introduction of object-oriented modelling in bioprocess using Python.

Learning Resources	
	1. James E.Bailey, David F.Ollis "Biochemical Engineering Fundamentals", 2nd Edition, Mc Graw Hill, 1986. 2. Pauline M. Doran "Bioprocess Engineering Principles", 2nd Edition, Academic press, 2012. 3. S.N.Mukhopadhyay "Process Biotechnology Fundamentals", 2nd Edition, 2004. 4. Michael L. Shuler, Fikret Kargi, Matthew De Lisa "Bioprocess Engineering: Basic Concepts", 3rd Edition, Prentice-Hall, 2017. 5. Ravindra Pogaku,"Horizons in Bioprocess Engineering"Springer,2019

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai,sam@orchidpharma.com	1. Dr.S.Senthil Kumar, IITG	1. Dr.M.Venkatesh Prabhu, SRMIST
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	2. Dr.N.Selvaraj, IITG	2. Dr.P.Radha, SRMIST

Course Code	21BTC210L	Course Name	BIOPROCESS ENGINEERING LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	explain the Residence Time Distribution in Stirred tank and Plug flow reactor
CLR-2:	describe the rheological and mixing behavior of fermented fluid
CLR-3:	analyze the oxygen mass transfer coefficient and deactivation kinetics
CLR-4:	evaluate the model parameters in microbial growth
CLR-5:	discuss the modern tool of programming microbial cultures

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	explore the Residence Time Distribution studies in Stirred tank and Plug flow reactor	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	understand the rheological and mixing behavior of fermented fluid	3	3	1	-	-	-	-	-	-	-	-	-	2	2	-
CO-3:	measure the oxygen mass transfer coefficient and deactivation kinetics parameters	3	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO-4:	estimate the model parameters in microbial growth	3	3	1	-	-	-	-	-	-	-	-	-	2	2	-
CO-5:	learn the modern tool for programming the microbial cultures	1	2	3	-	3	-	-	-	-	-	-	-	2	2	-

Unit-1 - Non-Ideal Reactors — **12 Hour**

Practice:

1. RTD studies in Stirred tank reactor
2. RTD studies in Plug flow reactor

Unit-2 - Fluid Flow and Mixing in Bioreactors — **12 Hour**

Practice:

1. Rheological study of fermented fluids
2. Regime analysis of a stirred tank reactor
3. Determination of mixing time in a stirred tank reactor

Unit-3 - Transport Phenomena and Scale-up in Bioreactors — **12 Hour**

Practice:

1. Determination of KLa by power correlation method
2. Determination of KLa by dynamic gassing out method
3. Deactivation kinetics of enzymatic reaction
4. Deactivation kinetics of microbial growth

Unit-4 - Models in Bioprocess — **12 Hour**

Practice:

1. Estimation of unstructured model parameters of bacterial culture
2. Estimation of unstructured model parameters of yeast culture

Unit-5 - Modelling and Simulation in Bioprocessing — **12 Hour**

Practice:

1. Modelling and simulation of Batch culture using MATLAB
2. Modelling and simulation of continuous culture using MATLAB
3. Modelling and simulation of Fed culture using MATLAB
4. Modelling of batch reactor using Python

Learning Resources	1. Hans-Peter Schmauder,"Methods in Biotechnology" Taylor and Francis Ltd, 2003. 2. Arvind Kumar Bhatt,"Basic Biotechniques for Bioprocess and Bioentrepreneurship"Academic Press, Elsevier ,2023	3. Shijie Liu,"Bioprocess Engineering Kinetics, Sustainability, and Reactor Design"Elsevier, 2020.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai.sam@orchidpharma.com	1. Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in	1. Dr.M.Venkatesh Prabhu, SRMIST
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	2. Dr.N.Selvaraj, IITG, selva@iitg.ac.in	2. Dr.P.Radha, SRMIST

Course Code	21BTC301J	Course Name	GENE MANIPULATION AND GENOMICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	assess the basic concepts and principles of utilization of different expression vectors for cloning from the perspective of engineers
CLR-2:	demonstrate the different strategies of gene cloning and construction of genomic and cDNA libraries
CLR-3:	analyze the concepts of structural and functional genomics with advanced cutting-edge technologies
CLR-4:	assess the applications of recombinant DNA technology in animals, plants, and microbial organisms
CLR-5:	develop and apply the strategies on altering gene expression in vitro and in vivo

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the foundations of modern biotechnology	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	design and conduct experiments involving genetic manipulation	-	-	2	-	-	2	-	-	-	-	-	-	-	-	3
CO-3:	illustrate the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems	2	-	-	-	-	-	-	2	-	-	-	-	-	-	3
CO-4:	apply modern biotechnology in the different areas like medicine, microbes, environment, and agriculture	3	-	-	-	-	3	-	-	-	-	-	-	-	-	3
CO-5:	discuss the cutting-edge techniques and their applications such as plant transformation, protein expression and genomic DNA library construction etc.	3	-	2	-	-	-	-	2	-	-	-	-	-	-	3

Unit-1 - Overview of Cloning and Vectors — **15 Hour**

Introduction to genomics and gene regulation; Fundamental requirement for DNA cloning; Prokaryotic and eukaryotic vectors; Phage vectors; Strategies for gene cloning; Enzymes in genetic engineering

Practice: 1. Genomic DNA isolation
2. Double digestion of Genomic DNA

Unit-2 - Preparation and Screening of DNA library — **15 Hour**

DNA Library; Preparation of DNA Libraries; Genomic DNA library; Overlapping and non-overlapping DNA fragments; Choice of vectors; Evaluation of genomic DNA library; cDNA library; Purification and separation of mRNA; cDNA synthesis; cDNA library construction; Evaluation of cDNA library; Screening libraries; Polymerase chain reaction (PCR) and its applications

Practice: 1. Double digestion of Vector
2. Preparation of recombinant vector
3. E. coli Transformation

Unit-3 - DNA Sequencing and Genomics — **15 Hour**

DNA sequencing strategies; Principles of DNA sequencing; Sanger's Dideoxy sequencing method; Automated DNA sequencing; Next generation sequencing; Genome sequencing; Next generation sequencing and its applications; Methods of nucleic acid detection; Random priming; Nick translation and End labeling; RNA labeling; Non-isotopic labeling; Structural genomics; comparative genomics; Microarray

Practice: 1. Colony PCR
2. Functional Assay

Unit-4 - Analysis and Manipulation of Gene Expression and Function — **15 Hour**

Regulation of gene expression at different levels; Factors influencing gene expression; Epigenetic regulation; Protein expression in prokaryotic and eukaryotic cells; Alteration of gene expression by mutagenesis; Methods for site directed mutagenesis

Practice: 1. RNA isolation
2. cDNA synthesis
3. Semi-quantitative PCR

Unit-5 - Applications of Cloning — **15 Hour**

Medical applications; Human and genetic diseases; DNA vaccines; Gene therapy; Study of gene function in vivo; Embryonic stem cells; Applications in Embryonic stem cells; Transgenics; Methods of producing transgenic mice; Over-expression; Gene knock-in; Gene knock-out; Conditional knock-out; Genome editing; CRISPER-Cas9; Guide RNA; Gene inactivation

Practice: 1. Quantitative PCR
2. Fold and Relative Gene Expression

Learning Resources

1. Jeremy W. Dale and Malcolm von Schantz, "From Genes to Genomes," John Willey and Sons Publications, 2002
2. Old. R.W and Primrose. S.B, "Principles of Gene Manipulation, An Introduction to Genetic Engineering," Blackwell Scientific Publications, 2014
3. S. B. Primrose and R. M. Twyman, "Principles of Gene Manipulation and Genomics"7th Edition,Wiley-Blackwell, 2006
4. T A Brown Gene Cloning and DNA Analysis: An Introduction 8th Edition, Wiley Blackwell Publisher 2020

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2-Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. N. Selvamurugan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. S. Barathi, SRMIST

Course Code	21BTC302J	Course Name	IMMUNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	introduce the science of immunology and a detailed study of various types of immune cells
CLR-2:	provide knowledge about immune systems produced molecules and their classification, structure, and function
CLR-3:	provide students with experience in methods used in immunology, particularly the use of specific antibody in biomolecular applications
CLR-4:	provide knowledge about major histocompatibility complex and acquired immune system, their cells and its interaction and how they fight against infectious diseases
CLR-5:	provide knowledge about dysregulation of immune system functioning, ways to strengthen immune system and how human body is designed and protected to fight against various pathogens

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the immune system, their structure, classification and function	-	-	2	-	-	-	-	-	-	-	-	-	1	-	1
CO-2:	summarize genetic control of antibody diversity, monoclonal antibodies and cellular immunology	-	-	2	2	2	-	-	-	-	-	-	-	1	-	2
CO-3:	determine various methods to assess immune function, their application and interpretation of the results	-	-	-	2	3	-	-	-	-	-	-	-	3	-	3
CO-4:	outline major histocompatibility complex, types, function and the role of acquired immune cells signalling and its function	-	-	2	3	-	-	-	-	-	-	-	-	2	-	2
CO-5:	categorize hypersensitive immune reaction, autoimmunity, vaccination and cancer immunology and Illustrate the processes function to protect human body against infective agents	-	-	-	3	-	1	-	-	-	-	-	-	1	-	2

Unit-1 - Immune System for Health — **15 Hour**

Overview of the immune system; Development and differentiation of the hematopoietic stem cells, Myeloid and Lymphoid lineage; Lymphatic system; Lymphoid organs – types; Innate lymphoid cells; Rhesus group types; incompatible blood transfusion and hemolytic disease; Receptors of Innate Immune system; Types of Immune cells, Innate Immunity; Anatomical and Physiological barriers; Acquired Immunity, Clonal selection theory; Comparative immunity - Plant Immune system, Vertebrate and Invertebrate Immune system; Immunogens, Antigens and Haptens; Requirements for immunogenicity; major classes of antigens; antigen recognition by T and B lymphocytes

Practice : 1: Laboratory safety principles and Blood grouping; Agglutination principle, blood group types, 2: Total Leukocyte count; Types of blood cells - Leukocyte counting, 3: Differential Leukocyte count

Unit-2 - Immunity of Secretory Proteins — **15 Hour**

Immunoglobulin structure, types and function; Antibodies biological and functional properties - Proteolytic digestion of antibodies; Monoclonal antibodies production and applications; B Cell differentiation -B cell receptor structure and B cell signal transduction; Antibody diversity - Light chain synthesis; Heavy chain synthesis;; Cytokine types and function; Cytokine receptor structure; Role of cytokines in diseases; Complement system - Regulation of complement pathway; Role of complement proteins in diseases

Practice: 1. Antigen – Antibody reaction I – Widal test- slide method, 2. Antigen – Antibody reaction II -rapid plasma reagin (RPR) test, 3. Single radial immunodiffusion (SRID) - titer value, zone of equivalence

Unit-3 - Methods to Assess Immune Status — **15 Hour**

Isolation of immune cells from Human and animals; Antigen- antibody interaction; antibody affinity and avidity; Hemaagglutination reaction - Coombs test – direct and indirect; precipitation reaction;; Quantitative Immuno assays; passive Immunodiffusion; Precipitation reaction; Active Immunodiffusion – Rocket immunoelectrophoresis, SDS-PAGE and Western blot; Quantitative Immuno assays - Radio-immunoassay, Immunoprecipitation; Immunofluorescence – Direct and indirect; Immunohistochemistry; flow cytometry, ELISA and types; Cell culture and experimental models, analysis of gene expression

Practice: 1. Ouchterlony gel diffusion - Antigen-Antibody specificity, 2. Active Immunodiffusion I - Rocket Immunoelectrophoresis, 3. Active immunodiffusion – II – Counter Current Immunoelectrophoresis

Unit-4 - T Cell Signalling and Major Histocompatibility Complex — **15 Hour**

Major histo-compatibility Complex(MHC) – types and function; antigen processing and presentations – Endogenous and Exogenous; Diversity of MHC molecules;; Antigen – Antibody interaction Standard and test antigen; Rocket Immunoelectrophoresis; Biology of T lymphocyte - T cell receptors and interaction with MHC; T-cell maturation - T-cell activation and differentiation; Thymic selection – Positive and negative selection; T-cell activation and cytokine secretion; Cytokine control of TH1 and TH2 CD4+; Function of CD8+ T cells, T Regulatory cells; T-cell and B-cell cooperation, Pathways of Activation

Practice: 1. Enzyme linked Immunosorbent assay (ELISA) – Qualitative, 2. Enzyme linked Immunosorbent assay (ELISA) – Quantitative, 3. Immunoprecipitation

Unit-5 - Immunity of Infection, Autoimmune Disorder and Cancer — **15 Hour**

Hypersensitive reactions - Type I, Type II, Type III and Type IV reaction; Immune responses to infectious diseases introduction; Viral disease-HIV infection; Bacterial disease-Tuberculosis; Parasitic disease - Malaria; Evading Mechanisms of pathogens; Vaccine history and principle; Active and passive Immunization; DNA vaccine, Edible vaccine and Adjuvants; Cancer Immunology introduction; Evidence for cancer Immunity; cancer Immuno therapy; Autoimmunity introduction; Genetic Basis of Autoimmunity; Classification of auto-immunity

Practice: 1. SDS-PAGE, 2. Western blotting – Demo, 3. Flow cytometry - Demo

Learning Resources	1. Sudha Gangal, Shubhangi Sontakke, Textbook of basic and clinical immunology, Universities Press, 2013	2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen, Kuby Immunology, 8th ed., W. H. Freeman and Company, 2018

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2-Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Dr. Joe Varghese, CMC Vellore, joevarghese@cmcvellore.ac.in	1. Dr.S.Nageswaran, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	2. Dr.S.Rupachandra, SRMIST

Course Code	21BTC303T	Course Name	PROTEIN ENGINEERING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	distinguish the organizational levels of protein structure
CLR-2:	appraise the structure-function correlation in selected proteins
CLR-3:	understand Mutagenesis based protein design
CLR-4:	construct 3D structure of protein from amino acid sequence
CLR-5:	discuss on the experimental techniques available for protein structure characterization

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	outline proteins and its properties at the elemental, molecular and structural levels	-	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	group the proteins based on super secondary structure of protein with its function	-	2	-	-	3	-	-	-	-	-	-	-	-	3	-
CO-3:	integrate protein biochemistry to design efficient protein structures	-	2	-	-	3	-	-	-	-	-	-	-	-	3	-
CO-4:	scoring and validating the methods of obtain protein structural data	-	-	-	2	3	-	-	-	-	-	-	-	-	-	3
CO-5:	mutagenesis experiments to test protein stability and/or function	2	-	-	2	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Characteristics of Proteins — **9 Hour**

Structure of amino acids- Properties of amino acids- Role of Glycine and Proline in structure determination- Ramachandran plot and its significance- Interactions that stabilize secondary -Structures, Structural features of alpha helix- Types of alpha helices- Parallel beta-strand structure-Anti-parallel beta-strand structure- Beta turns- loops and other secondary structures- Super- Secondary structures- Difference between motifs & domains- Types of motifs, Types of domains, Monomeric and polymeric proteins- hydrophobic collapse & theories of folding- Levinthal paradox- Role of chaperones- and heat shock proteins

Unit-2 - Structural features of Different Classes of Proteins — **9 Hour**

Role of Transcription factors in gene The isolation and characterization of proteins, Recombinant DNA technology and protein expression, Protein Digestion Techniques, Chemical and Enzymatic, Mass spectrometry, Tandem LC MS,/MS, Tools for mass spectrum analysis- Nature of interaction between p53 and DNA- effect of mutations in the DNA binding domain of p53- Effects of mutations in the oligomerization and Nuclear localization region-Structural elucidation of leucine zipper- Interaction of leucine zipper and DNA- - Structural elucidation of GPCR- Types of GPCR- Mechanism of activation of GPCR- Structural features of serine proteases

Unit-3 - Experimental Protein Structure and Functional Analysis — **9 Hour**

Methods of generating crystals- The isolation and characterization of proteins- Recombinant DNA technology and protein expression- Protein Digestion Techniques- Chemical and Enzymatic- Mass spectrometry - Tandem LC MS-/MS, Tools for mass spectrum analysis (ITC) Principle- Instrumentation of ITC- Determination enthalpy- entropy and free energy- Prediction of binding energy and multiple binding sites by ITC- Prediction of 3D structure from amino acid sequence, Homology modelling and threading

Unit-4 - Increasing Efficacy of Proteins — **9 Hour**

Protein Engineering in Basic and Applied Biotechnology- engineering new protein function- Engineering enzymes- Specificity- stability- antibodies- Denovo designs Fusion proteins- Protein engineering in Vaccine development- Protein engineering in biosensors- Case Study: Enhancing binding affinity of T4 lysozyme- Enhancing stability in T4 lysozyme

Unit-5 - Protein Expression Purification and Characterization — **9 Hour**

The isolation and characterization of proteins, Recombinant DNA technology and protein expression- Protein Digestion Techniques- Chemical and Enzymatic- Mass spectrometry - Tandem LC MS-/MS- Tools for mass spectrum analysis

Learning Resources

1. Whitford, David. Proteins: Structure and Function. Wiley, 2013.
2. Tooze, John, and Branden, Carl Ivar. Introduction to Protein Structure. United States, CRC Press, 2012.
3. Ben-Tal, Nir. Kessel, Amit. Introduction to Proteins: Structure, Function, and Motion. United Kingdom: CRC Press, Taylor & Francis Group, 2018.
4. Buxbaum, Engelbert. Fundamentals of Protein Structure and Function. Germany: Springer International Publishing, 2015
5. Lilia Alberghina, Protein Engineering For Industrial Biotechnology, Taylor & Francis, 2003.
6. Chatwal. G. R, "Instrumental methods of Chemical Analysis", Himalaya Publishing House, 5th Edition, 2011.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Priya Swaminathan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. Vasantharekha R, SRMIST

Course Code	21BTC304T	Course Name	ANIMAL BIOTECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	provide a basic understanding of animal breeding and animal health
CLR-2:	develop an understanding on raising animals using assisted reproductive techniques
CLR-3:	inculcate the understanding of cell culture technique and production of valuable products from them
CLR-4:	provide an understanding of alteration of animal body biological system
CLR-5:	give emphasis to transgenesis thereby improving livestock production

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	familiarize the students about breeding, biological markers for genetic diseases and managing animal health using vaccines	-	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO-2:	impart an understanding about Embryo transfer, fertilization methods and animal production	-	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO-3:	provide knowledge about different culture techniques, Characterization of cell lines and in vitro testing of drugs	-	3	2	-	-	-	-	-	-	-	-	-	3	3	-
CO-4:	provide knowledge about improvement of animals to increase the yield and quality of animal products	3	-	-	3	-	-	-	-	-	-	-	-	3	3	-
CO-5:	familiarize the students about livestock improvement using molecular pharming	3	-	-	2	-	-	-	-	-	-	-	-	-	3	3

Unit-1 - Animal Improvement for Desired Traits and Animal Health — **9 Hour**

Breeding, different types of breeding; Marker assisted Selection - Gene mapping and identification of genes of economic importance in farm animals; Animal Health: Common viral, bacterial and parasitic diseases affecting animals; Vaccines for animal health; Developing diagnostic kits for animal diseases

Unit-2 - Embryo Transfer and Animal Propagation — **9 Hour**

Assisted reproductive techniques in animals: Artificial insemination; In vitro fertilization- Superovulation, MOET,Embryo transfer,– Pregnancy diagnosis – Sexing of embryos, Embryo splitting; Cryopreservation of embryo; Cloning for conservation of endangered species; Stem cell technology & its applications

Unit-3 - Animal Cell Culture — **9 Hour**

Principles of sterile techniques and cell propagation – Primary cell culture, secondary cell culture, continuous cell lines, suspension cultures; Chemically defined and serum free media for cell culture; Preservation and characterization of animal cells; Scaling up of animal cell culture; organ culture; 3D printing; Application of animal cell culture in vitro testing of drugs; Cell culture as source of therapeutic protein production

Unit-4 - Biotechnology in Livestock Production — **9 Hour**

Manipulation of Growth hormone – somatotropic hormone – Thyroid hormone; Probiotics as growth promoters, Mode of action & uses of probiotics ; Manipulation of lactation – Lactogenesis – galactopoiesis ; Manipulation of rumen microbial digestive system; Manipulation of wool growth

Unit-5 - Transgenesis and Molecular Pharming — **9 Hour**

Trangenesis, Gene editing using CRISPR Cas9, Transgenic animals, Methods of producing transgenic animals, knockin, knock out, mutation models; Transgenic animals as models for human diseases; Transgenic animals in livestock improvement- Therapeutic protein expression using transgenic animals, Animal as bioreactors; Ethical issues in animal biotechnology, 3R's and alternative for animal models - In vitro testing & insilico modeling

Learning Resources	
1. Animal Biotechnology: Recent concepts and developments - P.Ramadas, MJP Publications, 2015.	3. Animal Biotechnology – M.M.Ranga, 3rd edition, 2007.
2. Animal Breeding and Genetics; Aggrey, S.E.; Rekaya, R. Spangler, M.L., Ed.; Springer: New York, NY, USA, 2022.	4. Culture of Animal cells; a manual of basic technique - R.Ian Freshney, 4th edition, Wiley publications, 2006.
	5. Textbook of Animal Biotechnology – P.Ramadas & S.Meerarani, 2nd edition, 2002.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr.S.Sujatha, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr.K.Venkatesan, SRMIST

Course Code	21BTC305L	Course Name	ANIMAL BIOTECHNOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	provide the basics of cell culture media and primary cell culture
CLR-2:	understand the rationale of sub culturing of cells and maintaining it
CLR-3:	analyzing the cellular content using specific staining methods
CLR-4:	distinguish between cell viability and cell cytotoxicity
CLR-5:	comprehend the applications of animal cell culture

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	develop hands on training in primary cell culture techniques	-	2	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	gain proficiency in culturing and maintaining cell lines	-	-	3	2	-	-	-	-	-	-	-	-	-	-	3
CO-3:	acquire skills to perform fluorescent staining procedures to visualize cellular content	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	critique the toxicity of drugs invitro	-	-	3	3	-	-	-	-	-	-	-	-	2	3	-
CO-5:	utilize cell culture techniques in emerging fields of animal biotechnology	-	-	-	3	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Media Preparation and Primary Cell Culture — **12 Hour**

Practice:

1. Preparation & Sterilization of media for animal cell culture
2. Isolation of Hepatocytes and checking its viability
3. Isolation and culturing fibroblasts from chick embryo

Unit-2 - Cell Culture and Maintenance — **12 Hour**

Practice:

1. Cell passaging
2. Cryopreservation of cells
3. Revival of Cryopreserved cells.

Unit-3 - Rapid Staining Procedures for Analysis of Cellular Content using Specific Fluorochromes — **12 Hour**

Practice:

1. Mitochondrial & Nuclear staining using fluorochromes
2. Detection of apoptosis using Annexin V
3. Detection of mycoplasmal contamination by Hoechst staining

Unit-4 - Cell Viability and Cell Cytotoxicity Assays — **12 Hour**

Practice:

1. Determination of Cell viability by MTT assay
2. Assessment of Cytotoxicity by LDH assay
3. Clonogenic assay

Unit-5 - Applications of Cell Culture — **12 Hour**

Practice:

1. Determination of glucose uptake by the cells using 2NBDG method
2. Demonstration on sorting of cells by flow cytometry
3. Mammalian cell transfection using lipofectamine

Learning Resources	1. Capes-Davis & Ian Freshney " Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications", 8th Edition, ISBN: 978-1-119-51304-9, 2021 Wiley-Blackwell	2. ATCC Animal Cell culture guide

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr.S.Sujatha, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr.K.Venkatesan, SRMIST

Course Code	21BTC306T	Course Name	PLANT BIOTECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the genome organization and gene expression in plants
CLR-2:	exercise the plants as production systems by altering the plant hormones for growth and development
CLR-3:	employ different methods for the development of transgenic plants
CLR-4:	interpret the mechanisms for the plant to cope with biotic and abiotic stresses
CLR-5:	apply the classical and modern plant breeding techniques for crop improvements

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	discuss the structure, organization of plant genomes and gene regulation	3	-	3	-	-	-	3	-	-	-	-	-	-	2	-
CO-2:	demonstrate the mechanism and role of plant tissue culture for mass multiplications	3	2	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	establish the various methods of genetic manipulation in plants	3	2	-		3	-	-	-	-	-	-	-	-	3	-
CO-4:	discuss the molecular aspects of plant adaptability to various stresses	3	-	2	-	-	-	3	-	-	-	-	-	-	-	3
CO-5:	apply the significance of plant breeding and genetic manipulations of plants for economic importance	3	-	-	-	3	-	3	-	-	-	-	-	-	3	-

Unit-1 - Plant Genomes: the Organization and Expression of Genes — **9 Hour**

Plant DNA, chromatin, chromosome structure. Nuclear genome, genome size, and organization. Chloroplast and mitochondrial - Genome structure, evolution, expression, and gene regulations. Eukaryotic gene expressions and its regulation - Transcription and translation levels: Organellar self-splicing, introns, and horizontal DNA transfer, RNA modification, post-transcriptional gene silencing (PTGS), Micro RNA - Production and interfering with the gene for silencing, DNA instability, Transposable elements in plants.

Unit-2 -Techniques for in Vitro Propagation of Plants — **9 Hour**

Introduction to plant tissue culture. Plasticity and totipotency of plant cells. The culture environment - physical and chemical factors. Plant growth hormones - classes and their roles. Stages of plant tissue culture. Culture types. Cybrids production, haploid production. Production of secondary metabolites.

Unit-3 - Tools and Techniques for Transgenic Plant Development — **9 Hour**

Introduction to Agrobacterium-mediated gene transfer and Biology. Ti-plasmid-process of T-DNA transfer and integration, transformation in the plant.Direct gene transfer methods - advantages and disadvantages. Basic features of vectors, optimization, and binary vectors. Alternative markers and reporter genes. The genetic manipulation of pest resistance crop plants, and Clean gene technology.

Unit-4 - Biotic and Abiotic Stresses of Plants — **9 Hour**

Plant stresses - Biotic stress: Plant–pathogen interactions, prokaryotes, fungi, and viruses. Disease resistance, natural disease resistance in plants. Biotechnological approach - Overexpression of PR-proteins. Herbs as biotic stress factors. Abiotic stresses: Natural and plant responses - The nature of water deficit stress. Various approaches for tolerance - salt, cold, and heat stress - Molecular mechanisms.

Unit-5 - Genetic Improvements in Agriculture — **9 Hour**

Introduction to crop improvement, crop plant domestication, and beyond. Breeding technologies: Advances in breeding technologies - Modern molecular plant breeding - Transgenic plants. Emerging technologies circumvent some concerns about transgenics. Applications of breeding. The second green revolution. Metabolic engineering: Molecular farming of carbohydrates, lipids, and protein. Producing fine chemicals, Plant-derived compounds as drugs. Current demand - the plants as alternative fuels

Learning Resources

1. *Slater. A, Scott.N.W and Fowler,M.R, "Plant Biotechnology - The genetic manipulation of plants", Oxford University Press 2008*
2. *Agnès Ricroch, Surinder Chopra, Marcel Kuntz. - Plant Biotechnology (2021). Springer Nature Switzerland AG 2021 Publisher. ISBN: 978-3-030-68344-3. Published: 31 August 2021. https://doi.org/10.1007/978-3-030-68345-0. 2nd Edition.*
3. *C Neil Stewart Jr. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2016)"- John Wiley & Sons, Inc., New Jersey ISBN: 978-1-118-82012. 2nd Edition.*
4. *Malik Zainul Abdin, Usha Kiran, Kamaluddin, Athar Ali. - Plant Biotechnology: Principles and Applications (2017). Springer Publisher, Singapore. ISBN: 978-981-10-2959-2 Published: 17 March 2017. https://doi.org/10.1007/978-981-10-2961-5.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. R. Pachaiappan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. S. Rupachandra, SRMIST

Course Code	21BTC401L	Course Name	PLANT BIOTECHNOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	relate the growth and development of natural and in vitro growth of plants for production systems
CLR-2:	comprehend the methods of nucleic acids isolation from plants
CLR-3:	apply various gene transfer methods in plants
CLR-4:	employ different steps for the production of plant secondary metabolites
CLR-5:	apply the classical techniques for crop improvement

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	develop in vitro plants for mass multiplication	3	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	contrast the different techniques for the isolation of nucleic acids for cloning and quantification of gene expression	2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	demonstrate the different steps for gene transfer methods and verify the transgene in plants	3	-	-	3	2	-	-	-	-	-	-	-	3	-	-
CO-4:	establish the cells for the production of bioactive plant secondary metabolites and methods for isolation and detection	3	2	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-5:	design the methods for the production of best traits and apply the plant pathology for crime investigation	3	2	-	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Techniques for in Vitro Propagation of Plants — **12 Hour**

Practice:

1. Preparation of plant tissue culture media - Murashige and Skoog's (MS) medium
2. Plant tissue culture - Direct and Indirect Organogenesis

Unit-2 - Plant Genomic DNA and RNA Isolation Techniques — **12 Hour**

Practice:

1. Isolation of plant genomic DNA - Salk line & CTAB methods - Qualitative and quantitative analysis of DNA
2. Extraction of total RNA from plant tissues using Trizol reagent - Qualitative and quantitative analysis of RNA

Unit-3 - Techniques for Transgenic Plant Development — **12 Hour**

Practice:

1. Transform the binary vector (pCAMBIA 1301) to Agrobacterium tumefaciens
2. Screening of Agrobacterium colonies for confirming transformation of pCAMBIA 1301 by colony PCR and Agrobacterium - Mediated gene transformation by Co-cultivation of plant leaf discs
3. Screening of transgenic plant tissues - GUS Reporter assay

Unit-4 - Plant Secondary Metabolites - Production, Isolation and Detection — **12 Hour**

Practice:

1. Development of Cell suspension culture for the production of secondary metabolites
2. Extraction and detection of plant secondary metabolites extract - Flavonoid - quercetin from onion dried peels and alkaloid - caffeine from Camellia sinensis - Tea / Detection by TLC and HPLC

Unit-5 - Applications of in Vitro Propagation & Plant Pathology — **12 Hour**

Practice:

1. Cybrids production through protoplast fusion
2. Somatic embryogenesis through endosperm culture
3. Crime scene investigation

Learning Resources

1. Plant Biotechnology Practical Manual - 2023.
2. C Neil Stewart Jr. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2016)"- John Wiley & Sons, Inc., New Jersey ISBN: 978-1-118-82012. 2nd Edition
3. Maheshwari, S.C. (1990). Tissue Culture, Molecular Biology and Plant Biotechnology — A Historical Overview. In: Sangwan, R.S., Sangwan-Norreel, B.S. (eds) The Impact of Biotechnology on Agriculture..Current Plant Science and Biotechnology in Agriculture, vol 8. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-0587-0_1
4. Çelik, Ö. (2018). Introductory Chapter: New Age Molecular Techniques in Plant Science. In (Ed.), New Visions in Plant Science. IntechOpen. https://doi.org/10.5772/intechopen.79360.
5. Methods in Plant Molecular Biology and Biotechnology by Bernard R. Glick. Published November 29, 2017, by CRC Press. ISBN 9780367412128

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. R. Pachaiappan, SRMIST
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Course Code	21BTC402J	Course Name	BIO SEPARATION TECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	know the importance of bio separation and its recovery economically
CLR-2:	learn the separation of product from solid –liquid phase
CLR-3:	know the techniques of isolation of bio-products
CLR-4:	learn the methods of purification of products
CLR-5:	learn the methods of polishing and formulation of products for packaging

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	categories the products into various sectors	1	2	1	-	-	-	-	-	-	-	-	-	1	2	1
CO-2:	identify the unit operation for separation	2	3	1	-	-	-	-	-	-	-	-	-	2	2	1
CO-3:	adapt the best methods of isolation of products	2	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO-4:	identify the sophisticated equipment for purification	2	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO-5:	know the polishing and formulation of the products	2	2	2	-	-	-	-	-	-	-	-	-	2	2	2

Unit-1 - Bioproducts Classification and Disruption Techniques — **15 Hour**

Classification of Bioproducts, Engineering Analysis, Analytical methods, Cell disruption Methods- Physical, Chemical, Mechanical and Biological methods.

Practice:

Cell disruption Techniques

1. Cell disruption by Sonication, 2. Cell disruption by High Pressure Homogenisation, 3. Chemical and Enzymatic method of cell disruption

Unit-2 - Separation of Insolubles — **15 Hour**

Electrical Double layers, Schulze–Hardy Rule, Flocculation Rate, Polymeric Flocculants, Sedimentation-Principles, Methods and Coefficients, Filtration Principles and Theory, Conventional Filtration- Filtration Equipments and Media, Scaleup and Design of Filtration Systems ,Cross flow filtration- Microfiltration, Centrifuges, Scaleup of Centrifugations.

Practice:

Recovery Methods

1. Cell separation by Flocculation, 2. Cell separation by Batch filtration, 3. Cell separation by Microfiltration, 4. Cell separation by Centrifugation

Unit-3 - Concentration of Solubles — **15 Hour**

Extraction-Batch,Staged,Differential Extraction,Aqueous two phase Extraction, Supercritical Extraction, Batch Adsorption, Adsorption in CSTR and Fixed Bed, Precipitation-Different methods of precipitation, Ultrafiltration, Dialysis and Electrodialysis.

Practice:

Protein Concentration Methods

1. Protein concentration by Precipitation methods, 2. Protein concentration by Ultrafiltration, 3. Protein Concentration by Aqueous two-phase extraction

Unit-4 - Protein Purification — **15 Hour**

Chromatography Column Dynamics, Plate Models, Chromatography Column Mass Balance with Negligible Dispersion, Dispersion Effects in Chromatography, Gradients and Modifiers, Adsorbent Types, Particle Size and Pressure Drop in Fixed Beds, Equipment, Scaleup.

Practice:

Purification of Protein

1. Protein purification by gel column chromatography
2. Protein purification by ion exchange chromatography

Unit-5 - Polishing — **15 Hour**

Crystallization Principles, Batch Crystallizers, Process Crystallization of Proteins, Crystallizer Scaleup and Design, Drying Principles, Dryer Description and Operation, Scaleup and Design of Drying Systems, Case studies.

Practice:

Polishing of Biomaterial

1. Crystallization Techniques
2. Freeze drying of biomaterials

Learning Resources

1. Harrison. R.G., Todd. P., Rudge S.R, Petrides. D.P, "Bioseparation Science and Engineering" Oxford University press, 2003.
2. Belter. P.A., Cussler, E., "Bioseparations", Wiley, 1985.
3. Nooralabettu Krishna Prasad, "Downstream Process Technology: A New Horizon In Biotechnology", PHI Learning Private Limited 2013
4. Mihir K Purkait; Randeep Sing,"Membrane Technology in separation science, CRC Press Taylor & Francis Group, 2018

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2-Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in	1. Dr.M.Venkatesh Prabhu, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Dr.N.Selvaraj, IITG, selva@iitg.ac.in	2. Dr.P.Radha, SRMIST

Course Code	21BTM191T	Course Name	BIOETHICS AND IPR	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	realize the need for ethical values in Biotechnology Research
CLR-2:	understand the risks associated with biotechnology Research
CLR-3:	know the type and extent of damage that could be caused to the environment
CLR-4:	understand the ethical and moral values to be inculcated in ethical decision making
CLR-5:	know the requirements for containment of risk group organisms

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	define Principles of Bioethics and aspects related to IP protection	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	elaborate the ethical issues and safety precautions in biotechnology research	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	explain concepts pertaining to exercising personal and environmental safety	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	examine case studies and ethical decisions in healthcare research	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	discriminate different biosafety levels and different forms of IP	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Basic Principles of Bioethics	**3 Hour**
Ethics and Bioethics, Ethical Theories, Use of animals in research and Ethical issues in Clinical Trials, Ethical issues in Stem Cell Research, Ethical Issues in In vitro Fertilization	
Unit-2 - Global Health Ethics	**3 Hour**
Health Systems and Institutions, Synaptogenesis and development of sensory-motor system, Ethical issues in Organ transplantation, Biobanking, Ethical issues in Regenerative Medicine, Religious and Cultural Perspectives in Bioethics	
Unit-3 - Biosafety Regulations	**3 Hour**
Transgenic Research and Field Trials, Roles of various regulatory bodies, Biosafety Rules for GMOs, Biodiversity and Environment conservation, CBD and Cartagena Protocol	
Unit-4 - Forms of IPR	**3 Hour**
Designs, Copyrights and Geographical indications, Novelty and Utility, Patentable subjects and protection in biotechnology, Biodiversity	
Unit-5 - Patens	**3 Hour**
Basic principles and general requirements of patent law Patents and methods of application of patents-Legal implications, Objectives of the patent system, TRIPs-GATT-International conventions, Patent Cooperation Treaty, Plant variety protection and farmer rights, other forms of IP	

Learning Resources	1. Singer and Viens (Eds.) Bioethics – Cambridge University Press, Cambridge,2008	2. The Indian Patent Act and Rules, 2015, GoI, India.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100%	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. DVL Saradha, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com	2. Dr Lilly M Saleena. SRMIST

Course Code	21BTE202T	Course Name	PHARMACEUTICAL BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the general principles of drug action
CLR-2:	demonstrate the parameters that affect the action of drug in human system
CLR-3:	relate the different type of adverse drug reactions and drug abuse
CLR-4:	explain the mechanism of action, and uses of antibiotics and Oligonucleotide therapeutics
CLR-5:	describe the regulation of drugs in Indian Government and its initiatives in promoting Indian System of medicine

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	select appropriate target, drug-like candidates based on desired pharmacokinetic and pharmacodynamics parameters	-	-	3	2	2	-	-	-	-	-	-	-	2	2	-
CO-2:	explain the logical usage of drugs and suggest appropriate treatment	-	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	evaluate the dose of drug to be administered for individuals	-	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-4:	explains the mechanism and improve their use of antibiotics and oligonucleotides as tools or potential therapeutics	-	-	3	2	3	-	-	-	-	-	-	-	2	2	2
CO-5:	explain the significance of laws pertaining to manufacturing, distribution and sale of drugs in India	-	-	-	-	-	-	2	2	-	-	-	-	-	1	2

Unit-1 - Pharmacokinetics — **9 Hour**

Routes of drug administration, Absorption of Drugs - Passsive transport and facilitated transport, Influence of pH on transport of molecules across membranes, Bioavailability. Distribution and Redistribution of drugs - Tissue storage, placental & brain transport. Biotransformation of drugs and types, Inhibition of drug metabolism, Induction of microsomal enzymes Routes of excretion of drugs - Rate of Clearance and Plasma half-life,

Unit-2 - Pharmacodynamics — **9 Hour**

Principles of drug action - Mechanism of drug action on receptors, enzymes, ion channels and transporters. Transducer mechanism. Dose-Response Relationship, Therapeutic efficiency, Factors modifying drug action. Pharmacovigilance - Casualty assessment, Side, secondary and toxic effects of drugs, Accidental overdose of drugs and the treatment, Drug Intolerance and Drug allergy, Drug abuse and Treatment

Unit-3 - Biotechnological Drugs Obtained by Microbial Synthesis. — **9 Hour**

Classification of anti-microbial agents based on chemical structure. Structure, classification, Mechanism of action and uses of beta-lactam, Tetracycline, aminoglycosides and Macrolide antibiotics

Unit-4 - Oligonucleotide Therapeutics — **9 Hour**

Introduction of oligonucleotide therapeutics and types of oligonucleotide therapeutics, Mechanism, application and limitations of Messenger RNA (mRNA), RNAi, Antisense therapeutics, DNAzymes, Oligonucleotide aptamers. Preparations in advanced phases of clinical trials. Other therapeutic and diagnostic potential of synthetic nucleic acids (drug delivery, aptasensors, etc.)

Unit-5 - Drug Regulatory System — **9 Hour**

Drug Regulatory body - CDSCO, Hierarchy at CDSCO, Functions of CDSCO, Functions of Central Drug-Inspectors, Functions of State Drug-Inspectors. Ayurvedic Formulary of India - Ayurvedic Dosage Forms, Ayurvedic Pharmacopoeia of India, Ayurvedic, Unani, Siddha drugs undertaken by British commission, Indian Government Initiatives to promote Ayurvedic products, Indian Government Initiatives to promote Unani and Siddha products

Learning Resources	
1	Laurence Brunton, Bjorn Knollmann, Randa Hilal-Dandan, "Goodman and Gilman's - The Pharmacological Basis of Therapeutics", McGraw-Hill Education, 13th Edition 2018, ISBN: 978-1-25-958473-2,
2	Nicolay Ferrari, Rosanne Seguin, "Oligonucleotide-Based Drugs and Therapeutics Preclinical and Clinical Considerations for Development" John Wiley & Sons, 1st Edition 2018
3	SK Gupta, Sushma Srivastava, "Textbook of Pharmacovigilance- Ensuring the Safe Use of Medicines", Jaypee Brothers Medical Publisher, 2st Edition 2018 https://cdsco.gov.in/opencms/opencms/en/Home/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	1. Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.in	1. Dr. M.K. Jaganathan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Dr. R. B Narayanan Anna University, Chennai, arbeen09@gmail.com	2. Dr. Y. Ravichandran,SRMIST

Course Code	21BTE303T	Course Name	COMPUTATIONAL MOLECUALR BIOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	analyze the databases in bioinformatics
CLR-2:	use sequence alignment to find similar sequences
CLR-3:	use alignment to build hierarchical lineages
CLR-4:	apply principles of bioinformatics to build tertiary structures of proteins
CLR-5:	analyze uses of Python programming in Bioinformatics applications

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the applications of bioinformatics to build databases for universal usage	2	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-2:	explain the concepts and tools to build alignment between similar sequences of DNA or Protein	2	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	illustrate the pattern of lineages and evolution	2	2	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-4:	examine the different methods in the construction of protein structure	3	2	-	2	3	-	-	-	-	-	-	-	-	2	3
CO-5:	evaluate the principles of Programming in Python for bioinformatics	2	2	-	2	3	-	-	-	-	-	-	-	-	2	3

Unit-1 - Molecular Biology Data Storage — **9 Hour**

Bioinformatics significance- Applications of bioinformatics- Internet Protocols. HTML script- Webpage creation- Human genome project-Uses of human genome project- The NCBI data model: Introduction - SEQ-Ids- BIOSEQs and BIOSEQ-SETs- SEQ-ANNOT and SEQ-DESCR- Genbank database- Genbank Flat file- Sequence submission to Genbank- Online and offline tools- Entrez - INSDC- Other databases in NCBI

Unit-2 - Database Resources in Molecular Biology — **9 Hour**

Introduction on databases & biological databases- Uses of biological databases- Primary sequence databases- Nucleotide- Protein sequence database- Primary structure databases- PDB file format- FASTA , GCG,VFF etc- High Throughput sequencing databases- Secondary databases- secondary sequence databases- Secondary structure databases- SCOP- CATH- Composite protein databases- Metabolic databases- SNP -databases- Whole genome - mendelian disease databases- chemical structure databases- bibliographic databases

Unit-3 - Sequence Analysis — **9 Hour**

Sequence alignment- Global Pairwise Alignment Algorithm- Solving problems- Local Pairwise Alignment Algorithm- Database searching- BLAST- FASTA- Multiple Sequence Alignmen:- Progressive and Iterative Alignment- Tools for pairwise alignment- tools for multiple sequence alignment- Application of Multiple Sequence Alignment- Databases Of Multiple Alignment- Molecular Phylogeny- Methods of phylogeny- types of trees - Tools for phylogeny- PAM and BLOSUM

Unit-4 -Protein Structure Analysis — **9 Hour**

Motifs and Patterns prediction, Databases for motif prediction, Databases for patterns and blocks, Secondary Database Searching, Secondary structure prediction, , Tools for secondary , structure prediction, , Specialized secondary structure prediction, Tertiary structure prediction, Comparative modelling, Abinitio modelling, Validation of tertiary structure, tools for homology , modeling , tools for structure validation, Structure visualization tools, Pymol, Chemical structure building tools, file formats for small molecules, file format conversion tools

Unit-5 - Python Coding in Molecular Analysis — **9 Hour**

Introduction of Python and text editors, String datatype, Tuples datatype, Lists datatype, Flow control: If else, For loop, While loop, Reading and Writing files, Modules in Python, Functions, Regular expressions: Syntax, Regex , examples, Biopython, Advantages of python in bioinformatics, Components of biopython: Alphabet, Seq, Seq object, SeqUtils, Align and clustalw with Biopython, BLAST Running and Processing with Biopython

Learning Resources

1. Pevsner, Jonathan. Bioinformatics and Functional Genomics. United Kingdom, Wiley, 2015.
2. Andreas D Baxevanis & B F Francis, "Bioinformatics- A practical guide to analysis of Genes & Proteins", John Wiley, 2002
3. T K Attwood, D J Parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st Edition, 11th Reprint 2005.
4. Jin Xiong , " Essential Bioinformatics", Cambridge University Press, 2006
5. Sebastian Bassi, " Python for Bioinformatics", 2nd Edition CRC Press, 2017
6. Ramalho, Luciano. Fluent Python: Clear, Concise, and Effective Programming. United States, O'Reilly Media, 2015.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Priya Swaminathan, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai, arbeen09@gmail.com	2. Dr. MK Jaganathan, SRMIST

Course Code	21BTE404T	Course Name	MARINE BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	learn the knowledge of the living and non-living resources
CLR-2:	analyze the pharmacological potency of toxins
CLR-3:	apply the biopolymers from various sources
CLR-4:	control measures of various marine pollution
CLR-5:	understand the commercialization of marine and aquaculture resources

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the economically important marine resources and their wealth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	explain the natural toxins and its pharmacological potency	-	2	2	3	-	-	-	-	-	-	-	-	2	2	2
CO-3:	distinguish the availability of bioactive compounds	-	2	2	3	2	-	-	-	-	-	-	-	2	2	2
CO-4:	value the degradation process for discharged wastes	-	2	2	3	2	-	-	-	-	-	-	-	-	-	-
CO-5:	integrate the diseases of cultivable animals and its controlling measures	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-

Unit-1 - Living and Non-Living Resources	**9 Hour**
Zonation of the sea; motion of the ocean; Living resources - Corals, seaweeds and mangroves. Non-living resources -Oil, gas and salts. Economically important animals - Finfishes, shrimps, crabs, edible oysters and pearl oysters.	
Unit-2 - Natural Toxins and its Potential Pharmacological Uses	**9 Hour**
Marie toxins from animals; sources of toxins; pharmacological potential of toxins- tetrodotoxin, conotoxin and ciguateratoxin.	
Unit-3 - Potential Bioactive Compounds	**9 Hour**
Biopolymers - collagen, gelatin, heparin, chitosan, antioxidants. Polyunsaturated fatty acids - omega 3-fatty acids. Sources of carotenoids.	
Unit-4 - Marine Pollution	**9 Hour**
Oil spillage - fate of spilled oil, methods of degradation. Harmful blooms- blue-green algal blooms, red tides. Pesticide pollution - degradation. Heavy metal pollution - minamata disease. Solid waste pollution - plastic waste and degradation, factors affecting degradation.	
Unit-5 - Finfish and Shellfish Diseases and Aquaculture	**9 Hour**
Finfish diseases; shrimp diseases associated with culture and management; antibiotics used in culture, immunostimulants, diagnostic kits. Water quality management in hatcheries and grow-out ponds.	

Learning Resources	
	1. Se-Kwon Kim (Ed.) "Springer Handbook of Marine Biotechnology", (Series) Springer Berlin, Heidelberg, 2015. 2. Milton Fingerman and Rachakonda Nagabhushanam, "Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing", Science Publishers, 2009. 3. ProkschandWerner E.G.Muller, "Frontiers in Marine Biotechnology",Horizon Bioscience, 2006. 4. Le Gal, Y., Ulber, R, "Marine Biotechnology I: Advances in Biochemical Engineering/Biotechnology", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96, 2005. 5. Le Gal, Y., Ulber, R "Marine Biotechnology II: Advances in Biochemical engineering /Biotechnology", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 97, 2005.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr.R.A.Nazeer, SRMIST
2. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceutical Ltd., Chennai	2. Prof. R. B. Narayanan, Ann University, Chennai, arbeen09@gmail.com	2. Dr.R.Jaiganesh, SRMIST

Course Code	21BTE405T	Course Name	VACCINE BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the conventional strategies in vaccine production
CLR-2:	develop an understanding in the vaccine production techniques
CLR-3:	categorise the types of vaccine
CLR-4:	analyze different methods of vaccine delivery
CLR-5:	comprehend the guidelines for vaccine management

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	acquire theoretical knowledge on conventional strategies in vaccine production	-	3	-	-	-	-	-	-	-	-	-	2	-	3	-
CO-2:	exemplify the students with vaccine production techniques	-	3	3	-	-	-	-	-	-	-	-	-	3	-	3
CO-3:	distinguish various types of vaccine	-	3	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-4:	devise various methods for vaccine delivery	3	-	-	3	-	-	-	-	-	-	-	-	-	3	3
CO-5:	explicate the guidelines for vaccine production and delivery	-	-	3	-	-	-	-	2	-	-	-	-	-	3	3

Unit-1 - Conventional Strategy and Current Developments In Vaccine — **9 Hour**

History of vaccine development -Conventional strategies for vaccine improvement; Live, attenuated, subunit, peptide and killed vaccines; Types of adjuvants; Current development in vaccines- Next-generation vaccines: Human Immunome project; Human antibodies as vaccines

Unit-2 - Vaccine Design and Development — **9 Hour**

Steps involved in vaccine production; Production techniques-Strain selection, growing the microorganisms in maximum titre; Technology related to monitoring -temperature, sterilization, environment, quality assurance, vaccine efficacy and lot release; Preservation techniques-cryopreservation and freeze drying

Unit-3 -Types, Methods and Applications — **9 Hour**

Types of vaccines- Inactivated toxins, Inactivated whole bacteria or viruses, Live attenuated bacteria or viruses, Subunit vaccines, Polysaccharide vaccines, Conjugate vaccines, Genetic approaches in vaccine development- Recombinant DNA vaccines, Edible vaccines; Recent developments in vaccine - Virus like particles, Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle based vaccine

Unit-4 - Vaccine Delivery — **9 Hour**

Immunomodulators-Innovative methods of delivering immunogens ; liposomes-role of liposomes in delivering vaccines-Mechanism of liposome formation; Microspheres-Types of microspheres, Preparation methods; ISCOMS-Properties of ISCOM based vaccines, Types, components of ISCOM

Unit-5 - Guidelines for Vaccine Management — **9 Hour**

Regulatory issues- Regulatory bodies, Environmental effects of recombinant vaccines; Disease security and biosecurity principles; OIE guidelines for vaccine seed lot management; OIE guidelines for the method of vaccine production, OIE guidelines for production facility; In process control and batch control-organization and responsibilities, documentation and evaluation of data; Test on final products-Overview, General manufacturing recommendations, Final product release tests

Learning Resources	1. Ronald W. Ellis, "New Vaccine Technologies", Landes Bioscience, 2001. 2. Noel Mowat, "Vaccine manual: The production and quality control of veterinary vaccines for use in developing countries", Daya books, 1999. 3. Cheryl Barton, "Advances in Vaccine Technology and Delivery", Espicom Business Intelligence, 2009. Vaccines: Stanley A. Plotkin, Walter A. Orenstein, Paul A. Offit(Elsevier), 6th edition, 2008 4. Ibrahim M Shnawa, "Vaccine Technology at A Glance", Boffin Access Limited, UK, 2019.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	1. Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.i	1. Dr.S.Sujatha, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Dr. R. B Narayanan Anna University, Chennai, arbeen09@gmail.com	2. Dr.Koustav Sarkar, SRMIST

Course Code	21BTE415T	Course Name	ENVIRONMENTAL BIOSENSORS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	create awareness on biosensors and the need for biosensors in day today life
CLR-2:	provide overview of various biomolecules used in biosensors
CLR-3:	reflects on the importance of biosensors in healthcare industries
CLR-4:	understand on the importance of biosensors in environmental monitoring
CLR-5:	educate the advanced state of the art of technology in biosensors

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	explain the biosensors components and its applications	3	-	2	-	2	-	3	-	-	-	-	-	3	-	2
CO-2:	acquire knowledge in biomolecules in biosensors	-	2	2	3	-	-	-	-	-	-	-	-	-	-	1
CO-3:	evaluate the importance of biosensors in healthcare industries	-	3	2	-	2	-	-	-	-	-	-	-	-	2	3
CO-4:	discuss the importance of biosensors in environmental monitoring	3	3	-	2	2	-	3	-	-	-	-	-	2	-	2
CO-5:	demonstrate in novel technologies in biosensors	3	-	2	-	2	-	-	-	-	-	-	-	2	3	-

Unit-1 - Basic Principle and Instrumentation of Biosensors — **9 Hour**

Introduction to biosensors; Various Types of Biosensors: electrochemical & opticals; acoustic & piezoelectric; Fluorescence & calorimetric; Materials for biosensors: Polymers; Metal Oxides; Photonic Crystals; Nano Materials.

Unit-2 - Biomolecules in Biosensors — **9 Hour**

Bioaffinity Based Sensor- DNA-Based Biosensors, Protein-Based Biosensors, Enzyme-Based Biosensors, Peptide-Based Biosensors, and Antibody-Based Biosensors. Real time applications - Glucose; Cholestrol; Urea; Pregnancy Kit, Pathogens & Detections.

Unit-3 - Biosensors in Healthcare Sectors — **9 Hour**

Biosensors in Health Cares: Biosensors and diabetes management; Biosensors in Cancers management; Biosensor in HIV early diagnosis (ELISA); Biosensors for Influenza Viruses.

Unit-4 - Biosensors in Environmental Monitoring — **9 Hour**

Biosensors in Environmental Monitoring: Water Quality – DO, BOD& COD Sensors; Heavy Metals. Biosensors for AIR Pollutions - Indoor pollutants detection, Gas Leaks Detectors. Biosensors In Agriculture Science - Soil Nutrients and Moisture Detection.

Unit-5 - Microfluidic Devices — **9 Hour**

Bioinspired Molecular Machines; Microfluidic Devices and Analysis; Microfluidics for Disease Diagnosis.

Learning Resources

1. *Modern Techniques in Biosensors Detection Methods and Commercial Aspects, herausgegeben von: Ph.D. Gorachand Dutta, Dr. Arindam Biswas, Prof. Dr. Amlan Chakrabarti, 2021.*
2. *Emerging Biosensor Trends in Organ-on-a-Chip, Mario Rothbauer & Peter Ertl, 2020.*
3. *Smart Biosensor Technology, George Knopf, Amarjeet S. Bassi, 2019.*
4. *Advanced Biosensors for Health Care Applications, Inamuddin, Raju Khan, Ali Mohammad, Abdullah Asiri, and 1st Edition - June 15, 2019.*
5. *Commercial Biosensors and Their Applications, Mustafa Kemal Sezgintürk, Clinical, Food, and Beyond, 1st Edition - June 12, 2020.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai	1. Dr. Dr. V V Raghavendra Sai,IIT Madras, Chennai, vvrsai@iitm.ac.in	1. Dr. W. Richard Thilagaraj,SRMIST
2. Mr. D.K.Rana, Heubach Colour Pvt.Ltd.Gujarat, ankplant@heubach-india.com	2. Dr. Athi N. Naganathan,IIT Madaras , Chennai, athi@iitm.ac.in	2. Dr. B.Samuel Jacob, SRMIST

Course Code	21MAB303T	Course Name	BIOSTATISTICS FOR BIOTECHNOLOGISTS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	gain knowledge in measures of central tendency, measures of dispersion, skewness and kurtosis through moments on statistical data
CLR-2:	understand the importance of probability distributions such as Binomial, Poisson and Normal distributions to solve biotechnology related problems
CLR-3:	learn how to formulate and test the hypothesis of single means and difference of means, single proportion and difference of proportions for large samples and to understand the sample
CLR-4:	gain knowledge on hypothetical tests about means and variances for small samples using the t test and F test, and apply the Chi-square test for goodness of fit and independence of attributes in biotechnological topics, Also, to have knowledge in ANOVA in biotechnology related topics
CLR-5:	gain knowledge in correlation and regression lines and the non-parametric tests in biotechnology

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	explain measures of central tendency and measures of dispersion	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply probability distributions applicable to biotechnology	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	examine the given problems relating to the large sample test of mean and difference of mean and Chi-square tests	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	infer from hypothesis tests by using the t-test, F- test, Chi-Square test and ANOVA	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	evaluate problems on concepts of correlation, regression and non-parametric tests	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Measures on Statistical Data — **12 Hour**

Introduction to discrete types of statistical data - Introduction to continuous types of statistical data- Measures of central tendency-Arithmetic mean, geometric mean, harmonic mean, median, mode - Measures of dispersion - Range, quartile deviation, mean deviation, median deviation, mode deviation and standard deviation- Coefficient of dispersion-Coefficient of variation – Raw moments and central moments and their relation. Measures of skewness and kurtosis - Karl Pearson's coefficient of skewness, Bowley's coefficient of skewness.

Unit-2 – Probability — **12 Hour**

Introduction to probability concepts, random experiment, trail, events - Types of events: Impossible, Simple, Mutually Exclusive and Independent events (only definitions, properties- without proof)- Addition and Multiplication Theorems on probability- Total Probability theorem - Baye's Theorem (without proof) and its applications- Introduction to one-dimensional random variable and its types-Expectation(Mean), Variance, Moments and moment generating functions-Binomial Distribution, Poisson Distribution and Normal Distribution.

Unit-3 - Large Sample Tests — **12 Hour**

Sampling Theory- Basic concepts- Population, Sample, Sampling distribution, population parameters and sample statistic- Testing of hypothesis, Null and Alternate hypothesis, Single-tailed and Two-tailed tests, Type-I and Type–II errors- Acceptance and Rejection Regions, Level of Significance, Degrees of freedom and Confidence limits – Large sample tests based on the normal distribution (Z-test)-Z-Test for single mean and for the difference of means, Z-Test for single proportion and difference of proportions

Unit-4 - Small Sample Tests — **12 Hour**

Small sample tests based on t- distribution- For single mean and for the difference of means – Paired t-test- F-test for equality of variances-The Chi-square test for goodness of fit and for Independence of attributes using a contingency table. One-way classifications- ANOVA, Two-way classifications- ANOVA.

Unit-5 - Correlation, Regression and Non-Parametric Tests — **12 Hour**

Karl Pearson's coefficient of correlations - Spearman's rank correlation coefficient-Regression lines and its applications- Non-parametric tests – The sign test – The Wilcoxon signed –ranked test- Rank sum tests: The Man Whitney U test -The Kruskal Walis test.

Learning Resources

1. Mario F. Triola, Elementary Statistics, Pearson, 13th edition, 2018.
2. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic press, Sixth Edition, 2021.
3. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, S.Chand & Co, Eleventh Edition, 2018
4. Richard I. Levin, David S. Rubin, Masood H. Siddiqui, S. Rastogi, Statistics for Management, Pearson, 8th edition, 2017.
5. Bernard Rosner, Fundamentals of Biostatistics, Brooks/core, 8th edition, 2015.
6. T. Veerarajan, Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks, 4th Edition, McGraw-Hill Education, New Delhi, 2015.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. R. Senthamarai, SRMIST

Course Code	21CSC206T	Course Name	ARTIFICIAL INTELLIGENCE	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	infer knowledge in problem formulation with AI
CLR-2:	exemplify the uninformed and informed search technique procedures for real world problems
CLR-3:	understand the adversarial search methods, constraint satisfaction problems and intelligent agents
CLR-4:	demonstrate various knowledge representation techniques
CLR-5:	infer knowledge about expert systems

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	formulate a problem as a state space search method and its solution using various AI techniques	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply appropriate searching techniques to solve a real-world problem	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	develop various game playing strategies to solve real world adversarial search problems	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	represent various knowledge representation techniques to solve complex AI problems	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	design an expert system to implement advance techniques in Artificial Intelligence	3	2	3	-	-	-	-	-	2	-	-	-	-	-	-

Unit-1- Introduction to AI — **9 Hour**

AI techniques, Problem solving with AI, AI Models, Data acquisition and learning aspects in AI, Problem solving- Problem solving process, formulating problems, Problem types and characteristics, Problem space and search, Toy Problems – Tic-tac-toe problems, Missionaries and Cannibals Problem, Real World Problem – Travelling Salesman Problem

Unit-2- Basic Introduction to Data Structure and Search Algorithms — **9 Hour**

Basic introduction to stacks, queues, trees and graphs - General Search Algorithms – Searching for solutions – Problem-solving agents – Control Strategies – Uninformed Search Methods – Breadth First Search – Uniform Cost Search - Depth First Search -Depth Limited Search – Informed search - Generate and test - Best First search - A* Algorithm

Unit-3 - Adversarial Search Problems and Intelligent Agent — **9 Hour**

Adversarial Search Methods (Game Theory) - Mini max algorithm - Alpha beta pruning - Constraint satisfactory problems – Constraints – Crypt Arithmetic Puzzles – Constraint Domain – CSP as a search problem (Room colouring). Intelligent Agent – Rationality and Rational Agent – Performance Measures – Rationality and Performance – Flexibility and Intelligent Agents – Task environment and its properties – Types of agents.

Unit-4 - Knowledge Representation — **9 Hour**

Knowledge Representation -Knowledge based agents – The Wumpus world – Propositional Logic - syntax, semantics and knowledge base building - inferences – reasoning patterns in propositional logic – predicate logic – representing facts in logic: Syntax and semantics – Unification – Unification Algorithm - Knowledge representation using rules - Knowledge representation using semantic nets - Knowledge representation using frames inferences - Uncertain Knowledge and reasoning Methods.

Unit-5 - Planning and Expert System — **9 Hour**

Planning – planning problem – Simple planning agent – Blocks world problem – Mean Ends analysis Learning - Machine learning - Learning concepts, methods and models Introduction to expert system – architecture of expert systems.

Learning Resources	
	1. Deepak Kemhani, First course in Artificial Intelligence, McGraw Hill Pvt Ltd, 2013 2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020. 3. Parag Kulkarni, Prachi Joshi, Artificial Intelligence –Building Intelligent Systems, 1st ed., PHI learning, 2015 4. Data Structures Schaum's Outlines Series, Seymour, Lipschutz, 2014.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	15%	-	15%	-	15%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	25%	-	25%	-	25%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, tenzai	1. Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham	1. Dr. A. Alice Nithya, SRMIST
		2. Dr. K. Senthil Kumar, SRMIST

Course Code	21CEO310T	Course Name	GLOBAL WARMING AND CLIMATE CHANGE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	gain knowledge about the earth system
CLR-2:	study the basics of climate parameters and climate change causing elements
CLR-3:	understand importance of global warming
CLR-4:	understand different mitigation measures against global warming and their protocol
CLR-5:	explore renewable resource usage to reduce global warming

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	apply the acquired knowledge on earth system	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-2:	identify the climate parameters and their impact due to human activates	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-3:	identify the climate change impact in various sector	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-4:	interpret different protocols related to climate change	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-5:	implement and analyze reason behind global warming, mitigation measures of climate change	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-

Unit-1 - Earth's Climate System — **9 Hour**

Introduction to earth system-hydrosphere, lithosphere, cryosphere, atmosphere and biosphere. Hydrological cycle and Carbon cycle. Atmosphere and its composition, Atmospheric stability and lapse rate, Ozone layer and its functions, Ozone depletion and ozone hole, Global warming and its impacts, Greenhouse gases and greenhouse effect, El Nino and La Nina

Unit-2 - Climate Indices and Extreme Events — **9 Hour**

Climatology, Paleoclimatology, Indian climate system and their classification, Role of land and ocean to regulate climate, Role of ice and wind to regulate climate, causes of climate change Milankovitch theory (natural cause), Human induced climate variations, Climate Extremes-Cyclones, thunderstorms, Tornadoes, Heat waves, Sea level rising-Ice melting, temperature rising, Floods and droughts. Energy balance of the earth

Unit-3 - Physical Evidences of Climate Change — **9 Hour**

Climate change impact in different sectors- Agriculture, Forestry, Fishery, Socio economic impact – tourism, Evidences of warming and change in atmosphere/ ocean circulations. Sea level changes and Shore line changes. Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers loss. Energy supply: Role of energy in development of human civilization, Emissions from energy generation. Role of energy in current climate change.

Unit-4 - International Responses to Climate Change — **9 Hour**

Climate change organization and programs, History of IPCC and UNFCCC, IPCC- Assessment report highlights, UNEP, Need for international protocols of climate change, Kyoto protocol, Montreal protocol, UNDP - United nations development program, Carbon credit and Clean development mechanism.

Unit-5 - Climate Change Adaptation and Mitigation Measures — **9 Hour**

Renewable and alternative energy technologies- Biomass, Solar, Hydro, Geothermal and Wind. Clean technology, biodiesel, compost, biodegradable plastics. Concept of sustainable development, Concept of carbon sequestration. Adaptation measures- Green building technology. Public awareness - Methods and ecology, economics and ethics: the missing links. Life cycle analysis, Role environmentalist.

Learning Resources

1. Dash Sushil Kumar, "Climate Change –An Indian Perspective", Cambridge University Press India Private limited 2007.
2. Adaptation and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 2006.
3. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006.
4. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on hydrological Regimes", Cambridge university press, 2003.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) – Formative CLA-1 Average of unit test (50%)		Continuous Learning Assessment (CLA) – Life-Long Learning CLA-2 (10%)		Summative Final Examination (40% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai	1. Dr. E. S. M Suresh, NITTTR, Taramani, Chennai.	1. Mr. K.C.Vinu Prakash, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board	2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University	2. Dr. K.Prasanna, SRMIST

Course Code	21CSO352T	Course Name	PYTHON PROGRAMMING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the basic programming syntax of Python
CLR-2:	understand various Looping statements and Functions
CLR-3:	acquire the Knowledge of object oriented feature in Python
CLR-4:	comprehend the significance of Lists, Sets and Tuples in Program Development
CLR-5:	acquire the knowledge of Files and handling Exceptions

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	apply the basic programming knowledge for Program Development	1	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	apply the knowledge of Loops and Functions to build application	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	design of real world application using Object oriented features	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	apply the concepts of Lists and Tuples for program optimization	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	design of Applications for data exchange using Files	1	-	3	-	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	**9 Hour**
Introduction - History of Python-Getting Started with Python-Programming style and Documentation-Identifiers-Variables-Assignment statements-Expressions- Data Types-Operators-Precedence-Comments-Type Conversions-Common Python Functions-Introduction to Methods and Strings	
Unit-2 - Loops and Functions	**9 Hour**
Introduction-Scope-IF Statements-Types of IF Statements-Conditional Expressions-Loops -While Loops-For Loop-Nested Loops-Functions-Definitions-Default Arguments-Calling a Function- Functions with or without returning values-Passings arguments to a function-Call by Value - Call by Reference-Recursion	
Unit-3 - Classes and Objects	**9 Hour**
Introduction to Object oriented Programming-Need of class and objects-Defining classes-Constructing Objects-Abstraction and Encapsulation-Overriding Methods - Inheritance and Polymorphism-Modules and Packages-Introduction to String Class-String Functions-Formatting Strings	
Unit-4 - Lists -Tuples-Sets	**9 Hour**
Introduction to Lists-Creation of List-Functions for Lists-Passing List to Functions-Operation on Lists-Searching and Sorting-Multidimensional Lists-Advanced List Processing - Sample programs on Lists-Lotto number and Deck of Cards-Introduction to Tuples-Sets - Creation and Accessing Sets-Dictionary Operations and Methods	
Unit-5 - Files and Exception Handling	**9 Hour**
Introduction - Structure of File - Opening and Writing Data-Accessing Files-File Dialogs-Retrieving data from web-Introduction to Exceptions-Errors and Exceptions-Command line arguments-Need for Exception-Handling Exceptions-Raising Exceptions-Exception Objects-Custom Exception Classes	

Learning Resources	1. Y.Daniel Liang, "Introduction to Programming using Python"1st edition, Pearson,2021, 2. Karl Beecher, "Computational Thinking-A beginners guide to problem solving and programming, 2017	3. Allen Downey, "Think Python - How to Think Like a Computer Scientist, Green Tea Press, 2021

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. D. Surendran, CEO, SKS Skill Fasteners Private limited	1. Dr. Kannimuthu.S, Professor, Karpagam College of Engineering,Coimbatore	1. Dr. P. Madhavan, SRMIST

Course Code	21MEO101T	Course Name	FUNDAMENTALS OF COMPOSITE MATERIALS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the fundamentals of composite materials
CLR-2:	apply the concept of anisotropic, isotropic, and orthotropic material behavior in the analysis of laminated structural components
CLR-3:	understand how composites are manufactured through various techniques
CLR-4:	recognize several methods employed in assessing the performance and quality of composites
CLR-5:	gain knowledge on recent advancements in composites and their applications

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the properties and characteristics of constituents in a composite material	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	analyze the mechanics of laminated composites subjected under different stresses	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	demonstrate the procedures involved in various composite processing techniques	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	choose the appropriate testing method to analyze the performance and quality of as-synthesized composites	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	express the importance and applications of advanced composites	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Composite Materials — **9 Hour**

Composites – definition and need, properties, advantages, disadvantages, and applications of composites. Composite architectures. Classification– matrix and fiber-based reinforced composites. Reinforcements – particles, flakes, whiskers, short fibers, continuous fibers, or sheets. Matrix materials –metals, polymers, and ceramics. Interfaces- concept of load transfer, bonding mechanisms.

Unit-2 - Mechanical Analysis of Composites — **9 Hour**

Micromechanics – rule of mixtures, elastic constants, mechanical and thermal properties, mechanics of load transfer from matrix to fiber. Macro mechanics –elastic constants of an isotropic material and lamina. Laminated composites- stresses and strains and analysis of laminated composites. Stresses and deformations in fiber-reinforced materials. Damage in composite materials – mechanisms.

Unit-3 - Composite Processing — **9 Hour**

Thermoset matrix composites–hand layup and spray techniques, filament winding, pultrusion, resin transfer molding, and autoclave-based methods. Thermoplastic matrix composites – injection molding, compression molding, sheet molding compound, and thermoforming. Metal matrix composites: solid, liquid and powder state processes. Ceramic matrix composites: hot pressing, reaction bonding processes, infiltration, in-situ chemical reaction techniques, sol-gel, polymer infiltration and pyrolysis (PIP), self-propagating high-temperature synthesis (SHS), and electrophoretic deposition.

Unit-4 - Composite Performance and Quality Inspection — **9 Hour**

Tension, compression, flexural, shear, single fiber pull-out, single fiber push-out and push-down test– indentation and three-point bending. Water absorption and flammability tests. Non-destructive testing methods - ultrasonic inspection, radiography, acoustic emission, and acoustic-ultrasonic method

Unit-5 - Advanced Composites — **9 Hour**

Un-conventional composites – carbon fiber/carbon matrix composites and multifilamentary superconducting composites. Nanocomposites – polymer clay nanocomposites, self-healing composites, self-reinforced composites, bio-composites, and hybrid composites. Electronic grade MMCs. Manufacturing of green composites.

Learning Resources

1. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer International Publishing, 2019.
2. An Introduction to Composite Materials, D. Hull & T.W. Clyne, Edition 3rd, Cambridge University Press, 2019.
3. Mallick, P.K. and Newman. S, Composite Materials Technology, Hanser Publishers, 2003.
4. M. Balasubramanian, Composite Materials and Processing, CRC Press, Taylor and Francis Group, 2014.
5. Barbero, Ever J, Introduction to composite materials design, Edition 3rd, CRC press, 2018.
6. Ramesh, Talreja, and Singh V. Chandra, Damage and failure of composite materials, Cambridge, United Kingdom, 2012.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr S. Srinivasan, Ashok Leyland srinchand@gmail.com	1. Dr. G. Arthanareeswaran, NIT, Tiruchirappalli arthanareeg@gmail.com	1. Dr. Shubhabrata Datta, SRMIST
2. Mr.A.Venugopal, WABCO venugopal.a@wabco-auo.com	2. Dr. R. Elansezhian, Pondicherry Engineering College. elansezhianr@gmail.com	2. Mr. S. Sasikumar, SRMIST.

Course Code	21CSS303T	Course Name	DATA SCIENCE	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science and Business Systems	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the basics of data
CLR-2:	learn the Pandas library to analyze data frames
CLR-3:	utilize different methods of data acquisition and data cleaning
CLR-4:	explore the visualization tools for different kinds of input data formats
CLR-5:	apply supervised and unsupervised learning to learn the hidden patterns from the data and predict the output

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the relationship between data	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-2:	identify the different data structures to represent data	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-3:	identify data manipulation and cleaning techniques using pandas	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-4:	constructs the Graphs and plots to represent the data using python packages	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-5:	apply the principles of the data science techniques to predict and forecast the outcome of real-world problem	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Data Science, Numpy and Pandas — **10 Hour**

Introduction to Data science: Facets of data, Data Science Process Introduction to Numpy: Numpy, creating array, attributes, Numpy Arrays objects: Creating Arrays, basic operations (Array Join, split, search, sort), Indexing, Slicing and iterating, copying arrays, Arrays shape manipulation, Identity array, eye function Pandas: Exploring Data using Series, Exploring Data using DataFrames, Index objects, Re index, Drop Entry, Selecting Entries, Data Alignment, Rank and Sort, Summary Statistics, Index Hierarchy Data Acquisition: Gather information from different sources, Web APIs, Open Data Sources, Web Scrapping.

Unit-2 - Data Wrangling, Data Cleaning and Preparation — **10 Hour**

Data Handling: Problem faced when handling large data-General techniques for handling large volume of data- General programming tips for dealing large data sets Data Wrangling: Clean, Transform, Merge, Reshape: Combining and Merging Datasets, Merging on Index, Concatenate, Combining with overlap, Reshaping, Pivoting Data Cleaning and Preparation: Handling Missing Data, Data Transformation, String Manipulation, summarizing, Binning, classing and Standardization, outlier/Noise& Anomalies.

Unit-3 - Visualization — **10 Hour**

Customizing Plots: Introduction to Matplotlib, Plots, making subplots, controlling axes, Ticks, Labels and legends, annotations and drawing on subplots, saving plots to files, matplotlib configuration using different plot styles, Seaborn library. Making sense of data through advanced visualization: Controlling line properties of chart, creating multiple plots, Scatter plot, Line plot, bar plot, Histogram, Box plot, Pair plot, playing with text, styling your plot, 3d plot of surface

Learning Resources

1. Grus, J. (2019). Data Science from Scratch, 2nd Edition. O'Reilly Media, Inc.
2. Jiawei Han, Micheline Kamber and Jian Pei (2012), Data Mining Concepts and Techniques, Third Edition, Elsevier.
3. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali (2016), Introducing Data Science: Big data, machine learning, and more, using Python tools, Manning Publications.
4. McKinney, W. (2018). Python for data analysis: Data wrangling with pandas, NumPy, and IPython. O'Reilly Media, Inc.
5. Vanderplas, J. T. (2017). Python data science handbook: Essential tools for working with data. O'Reilly Media, Inc.
6. Jeffrey S. Saltz and Jeffrey M. Stanton (2018), An Introduction to Data Science, Sage Publication.
7. Shai Vaingast (2014), "Beginning Python Visualization Crafting Visual Transformation Scripts", Second Edition, Apress.
8. Wes Mc Kinney (2012). "Python for Data Analysis", O'Reilly Media.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) – Formative CLA-1 Average of unit test (50%)		Continuous Learning Assessment (CLA) – Life-Long Learning CLA-2 (10%)		Summative Final Examination (40% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Veeramanickam. M.R.M, Associate Professor Chitkara University Institute of Engineering and Technology	1. Mr. Snehith Allam Raju Senior Manager Advanced Analytics & Architecture Envista Holdings Corporation, Hyderabad.	1. Dr.V.Kalpana, SRMIST
		2. Dr.G.Vadivu, SRMIST

Course Code	21LEH101T	Course Name	COMMUNICATIVE ENGLISH	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	provide an understanding about the importance of communication focusing on primary language skills (LSRW) in personal and professional contexts and also give practice to the learners in writing brief paragraphs using appropriate techniques
CLR-2:	enable the students to efficiently use English for accessing scientific and technical knowledge
CLR-3:	introduce the students the methods of using efficiently English in gaining knowledge through the internet and the vice versa, To make them understand the importance of acceptable online behaviors and the factors behind multiplicity in media projections of an event
CLR-4:	improve the learners' employability related communication skills and thereby equipping themselves for the increased opportunities for employment
CLR-5:	equip the learners with the appropriate business vocabulary by introducing them to the nuances of business communication

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	demonstrate the various types, modes, channels and barriers of communication, focusing on LSRW skills and put this awareness into effective use	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-2:	incorporate the meanings of technical terms in a scientific text and explain the manufacturing process and interpret data	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-3:	analyze digital platforms not only to acquire information from e-sources for developing research skills, analytical skills and problem-solving skills, but also to create e-content following the etiquettes of social media	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-4:	develop an understanding of the employability skills and how to develop them, which will gradually help them in their career exploration process	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-5:	apply nuances of business communication effectively	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-

Unit-1 - Understanding Communication — **9 Hour**

Introduction to Definition and Process of Communication, Types of communication - verbal and nonverbal - Channels of communication –communication of contexts - types of contexts - barriers to communication- Basic listening models- Competitive or combative listening, passive and attentive listening, Active and reflective listening- Barriers of communication- -barriers to effective listening- Listening to speeches of pioneer engineers and making a critical review on them - Delivering presentations- extempore on language learning experiences – prepared speech on language learning strategies - Presentation techniques -Creating Visual Support-Developing Paragraphs -Strategies to manage the writing process, Précis Writing- Creative Writing- Expository essay- writing for clarity- summarizing – paraphrasing - Story through images, Autobiography of Concrete objects - writing slogans-Types of phrases, clauses and sentences- Sentence patterns - Word order of English

Unit-2 - English: The Language of Science & Technology — **9 Hour**

Scientific method and Engineering Design Process - Single sentence definition and Extended definition of technical terms-Describing types of technical problem through verbs and adjectives describing technical problems-Assessing and interpreting faults through words describing faults and their severity; phrases describing certainty/uncertainty; adjectives with prefixes describing technical problems- text :Air Transat Flight 235 Discussing dimensions and precision through phrases related to scale ;Describing design phases and procedures through phrases related to tolerance, length, width, thickness, etc., - Task-based activities- describing /explaining /defining /classifying objects, etc. - Scientific and technical texts, Skimming for main ideas, Scanning for specifics, Predicting, inferring and guessing the meaning, etc- note making- Abstracting-

Interpretations & Transcoding (Pie Chart, Bar Diagram, Flow chart, Tables) - writing Instructions and Checklists -process description -describing the working of a machine and the manufacturing process- assignment and thesis writing -activity verbs-paper presentation -Specific Grammar Items in Scientific and Technical Communication (Use of modal auxiliaries in technical English, Conditional sentence connectives in technical communication.

Unit-3 - English in Digital World — **9 Hour**

Framing of search terms / keywords in search engines - tools to support synchronous communication such as webinar platforms, and asynchronous communication such as forums and social media. - What is online communication - types of online communication - advantages and disadvantages of online communication - Acceptable online roles and behaviors - netiquettes- etiquettes of social media – problems and opportunities in handling digital resources - presenting with audio and visual aids - Listening to the voice over of a short film/documentary - ted talks- Observing non-verbal cues- learning IPA, framing question tags, stress and intonation through online sources -Tools to check grammar, to cite references, to design logos, to check plagiarism - importance of academic integrity- analyzing the reasons why different sources take different angles while Mass media gives shape to an event as perceived in multiple countries.

Unit-4 - English for Employability — **9 Hour**

Difference between career and job-Listening to interviews (choice of career) - Group discussion, Interview skills (Preparation for Interviews, Stress management), Telephone Interview conversation, Mock Interviews -Email writing, Email etiquettes, Job application and Curriculum Vitae - letter of motivation - it's role in job application - components of letter of motivation- critical reasoning- analyzing the text -Vocabulary building strategies - techniques of correct understanding of a text - Reading comprehension - Types of reading- Skimming, Scanning, Extensive reading and Intensive reading-Analogy, Error analysis, Abbreviations, Acronyms and Initialism -synonyms and antonyms, parallelism

Unit-5 - Business English — **9 Hour**

Appropriate interactions in right contexts- role of interactions in team building - role of paralinguistic features in business communication - Role plays on –customer-centric marketing methods,- Telephone conversation-Negotiation-Listening to talks, Business conversations (short and long)-customer relationship management, methods of retaining customers.-Drawing and describing an organizational chart -Conducting meetings- writing notice, agenda and minutes-Writing paragraphs on the case studies, articles related to ethics- employment trends, Business English vocabulary- Report Writing (Feasibility and sales)- Memo-Circular-Public Notice - Enquiry & complaint letter- Proposal writing- writing Advertisement- caption and slogan Poster-Brochure-Voices , Tenses, Direct and Indirect, Connectives- Concord and Comparative forms

Learning Resources	
1. Swan, Michael. Practical English Usage. OUP, 1995. 2. Kumar Sanjay and Pushpa Lata. Communication Skills. OUP, 2011. 3. Scientific English: A Guide for Scientists and Other Professionals, 3rd Edition Paperback – Import, 16 June 2011	4. Graduate Attributes, Learning and Employability (English, Electronic book text, Hager Paul J) 5. Great Business English - Phrases, Verbs and Vocabulary for Speaking Fluent English by Hilary F. Moore Mba · 2013

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	10%	-	10%	-
Level 2	Understand	10%	-	10%	-	10%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	20%	-	20%	-	20%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Usha Kodandaraman, ABK AOTS, Chennai. drushak@gmail.com	1. Dr. S. P. Dhanavel, IIT, Chennai. dhanavelsp@iitm.ac.in	1. Dr. P. Tamilarasan, SRMIST.
2. Ms. Steffi Pearl Vinodhini, LIC Financial Advisor, Chennai. Steffipearl8@gmail.com	2. Dr. S. Vijayakumar, B.S. Abdur Rahman Crescent Institute of Science and Technology, Chennai. vijayakumar@cresent.education	2. Dr. M.M. Umamaheshwari, SRMIST.

Course Code	21LEH104T	Course Name	GERMAN	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	help students learn about the country, its culture, basic grammar elements such as greetings, self - introduction, alphabet and numbers
CLR-2:	familiarize the basic sentence structure with corresponding verb conjugations
CLR-3:	introduce nominative elements and directions
CLR-4:	introduce accusative and time elements
CLR-5:	prioritize using modal verbs, separable verbs and possessive pronouns in real - time conversation

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	demonstrate the features of culture, geography, greeting and self - introduction	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2:	construct simple sentences with personal pronouns and corresponding verb conjugations	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3:	develop sentences with nominative elements and directions	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4:	create conversational sentences using accusative and time elements	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5:	express thoughts in sentences using modal verbs, separable verbs and possessive pronouns in real - time conversation	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 - **9 Hour**

Begrüßungen und Verabschiedungswörter, Sich vorstellen - Name, Zahlen (bis 100), Länder und Sprachen, Wohnort, Berufe, Hobbys, Verb Konjugationen - kommen, wohnen, leben, heißen, sein und sprechen, Buchstabieren, Telefonnummer und E - Mail - Adresse nennen, Bundesländer und Hauptstädte, W - Fragen - Wer, Wie, Wie alt, Was, Woher, Wo, Welche Warum, Tage, Monate, Jahreszeiten, Zeitangaben am, im, Grundsätzliche Redewendungen.

Unit-2 - **9 Hour**

Personal Pronomen im Nominativ, Konjugation - Regelmäßige Verben und Unregelmäßige Verben ausführlich lernen, Zahlen bis eine Million, Satzbau formulieren - Aussage Satz, Ja / Nein Frage Satz und W - Frage Satz, Formular ausfüllen, Grundsätzliche Redewendungen.

Unit-3 - **9 Hour**

Wortschatz lernen - Plätze und Gebäude, Verkehrsmittel, Schulsachen, Technik und Geräte benennen, Adjektiv - Gegenteile, Nominativ - Bestimmter Artikel der, die, das, Unbestimmter Artikel ein, eine, ein, Negation kein, keine, kein, Nach dem Weg fragen und einen Weg beschreiben - links, rechts, geradeaus und die Himmelrichtungen, Ordinal Zahlen lernen, einen Text verstehen und antworten.

Unit-4 - **9 Hour**

Lebensmittel - Über Essen und Getränke sprechen, Einkauf planen, Über preise wissen, Akkusative Bestimmter Artikel den, die, das, Unbestimmter Artikel einen, eine, ein, Negation keinen, keine, kein, Verben mit Akkusativ, W Fragen - Wen, Wie viel, Wohin, Wann, Wie oft, Wie viele, Wie lange, Die Uhrzeit verstehen und nennen - Singular und Plural, Texte verstehen und antworten.

Unit-5 - **9 Hour**

Modal Verben - müssen, können, wollen, sollen, möchten, dürfen, mögen, Modal Verb im Satz, Kurze Alltags Gespräch führen und verstehen, Trennbare Verben, Possessive Pronomen im Nominativ - mein, dein, sein . . ., Über die Familie schreiben und sprechen, Andere vorstellen, Präteritum - sein und haben, Texte verstehen und antworten.

Learning Resources	1. Netzwerk A1.1 Neu, Klett, München

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Y. S. Kiran Kumar, Robert Bosch, Bangalore.	1. Dr. Dagmar Hellmann Rajanayagam, Professor, Universität Passau, Bayern, Germany.	1. Dr. P. Tamilarasan,SRMIST.
	2. Dr. J. Mangayakarasi, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai.	2. Mr. G. Sugumar, SRMIST.
		3. Ms. Bhuvana Udhaykumar, SRMIST.

Course Code	21BTB105T	Course Name	CELL BIOLOGY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	provide the basic concepts and understanding of cell structure and function
CLR-2:	explain the different strategies of the organization of organelles
CLR-3:	familiarize the concepts of structural and functional orientation in eukaryotes
CLR-4:	serve as a platform to study the molecular mechanism of cellular transport
CLR-5:	integrate the applications of different receptors and their role in diseases

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	explicate the fundamentals of cell biology	2	-	3	-	-	-	-	-	-	-	-	-	-	3	3
CO-2:	relate cell structures and functions	-	-	3	3	-	-	-	-	-	-	-	-	-	3	3
CO-3:	explain the basis of cell structure and its function in cell development and death	-	-	-	3	2	-	-	-	-	-	-	-	-	3	3
CO-4:	describe the steps involved in cell-cell signaling in mammalian cell systems	-	-	3	3	-	-	-	-	-	-	-	-	-	2	3
CO-5:	critique the fundamentals and relate with the advances in the various areas of diagnostic and therapeutic applications of cells	-	3	-	3	-	-	-	-	-	-	-	-	-	3	3

Unit-1 - An Overview of Cells and Cell Research	**6 Hour**
Origin and evolution of cells, Origin of Prokaryotes, Eukaryotes and Development of multicellular organisms; Cells as experimental models; Tools of cell biology, Molecular composition of cells, Cell membrane	
Unit-2 - Cell, Structure and Function–I	**6 Hour**
Nucleus, Endoplasmic reticulum, Golgi apparatus, Lysosomes, Mitochondria, Chloroplasts and Peroxisomes	
Unit-3 - Cell, Structure and Function–II	**6 Hour**
Cytoskeleton: Actin and myosin filaments, Intermediate filaments and Microtubules; Transport of molecule; Cell-cell interactions: Adhesion junctions, tight junctions, gap junctions	
Unit-4 - Cell Signaling	**6 Hour**
General principles of cell signaling-Modes of cell-cell signaling, Pathways of intracellular signal transduction-function of cell surface receptors; GPCR pathway, MAPK pathway	
Unit-5 - Cell Regulation	**6 Hour**
Cell division, Cell cycle and its regulation; Mitosis, Meiosis; Cell death: Necrosis, Apoptosis; Cancer-Introduction to cancer, types of cancer, Epithelial cell cancer; Stem cells and its therapeutic applications	

Learning Resources	
1. Channarayappa, "Cell biology," Universities Press, 2010. 2. Rastogi, S.C, "Cell biology," New Age International Publishers, 2005. 3. Thyagarajan S, N.Selvamurugan, MP Rajesh, RA.Nazeer Richard W Thilagaraj, S Barathi, MK Jaganathan., Biology for engineers McGraw Hill Education. 2012"Biology for Engineers " Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012	4. .Ajoy Paul, "Textbook of cell and molecular biology", Second edition, Books & Allied (P) Ltd., 2009.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr.S. Sujatha SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd.,sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. K Venkatesan SRM IST

Course Code	21MAB101T	Course Name	CALCULUS AND LINEAR ALGEBRA	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	apply the concept of Matrices in problems of Science and Engineering
CLR-2:	utilize Taylor series, Maxima minima, composite function and Jacobian in solving various Engineering problems
CLR-3:	apply the concept of Differential Equations in problems of Science and Engineering
CLR-4:	utilize the concepts of radius of curvature, evolute, envelope in problems of Science and Engineering
CLR-5:	apply the Sequences and Series concepts in Science and Engineering

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	apply the concepts of Matrices to find Eigenvalues and Eigen Vectors problems solving in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply Maxima and Minima, Jacobian, and Taylor series to solve problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	solve the different types Differential Equations in Science and Engineering applications	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	identify Radius, Centre, envelope and Circle of curvature and apply them in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	identify convergence and divergence of series using different tests in Engineering applications	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Matrices **12 Hour**

Characteristic equation – Eigen values and eigen vectors of a real matrix – Properties of eigen values – Cayley – Hamilton theorem – Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations

Unit-2 - Functions of Several variables **12 Hour**

Function of two variables-Partial derivatives - Total differential - Taylor's expansion with two variables up to second order terms -Maxima and Minima - Constrained Maxima and Minima by Lagrangian Multiplier - Jacobians of two Variables - Jacobians Problems - Properties of Jacobians and Problems

Unit-3 - Ordinary Differential Equations **12 Hour**

Linear equations of second order with constant coefficients when PI=0 or exponential - Linear equations of second order with constant coefficients when PI=sinax or cos ax - Linear equations of second order with constant coefficients when PI=polynomial Linear equations of second order with constant coefficients when PI=exponential with sinax or Cosax - Linear equations of second order with constant coefficients when PI= exponential with polynomial - Linear equations of second order with constant coefficients when PI=polynomial with sinhax or coshax - Linear equations of second order variable coefficients - Linear equations of second order variable coefficients - Homogeneous equation of Euler type - Homogeneous equation of Legendre's Type - Homogeneous equation of Legendre's Type - Equations reducible to homogeneous form - Equations reducible to homogeneous form - Variation of parameters - Variation of parameters - Simultaneous first order with constant co-efficient. - Simultaneous first order with constant co-efficient. - Simultaneous first order with constant co-efficient.

Unit-4 - Differential Calculus and Beta Gamma Functions **12 Hour**

Radius of Curvature – Cartesian coordinates - Radius of Curvature – Polar coordinates - Circle of curvature - Centre of curvature -Evolute of a parabola - Evolute of an ellipse - Envelope of standard curves - Beta Gamma Functions - Beta Gamma Functions and Their Properties Sequences – Definition and Examples - Series – Types of Convergence - Series of Five terms – Test of Convergence- -Comparison test – Integral test

Unit-5 - Sequence and Series **12 Hour**

Series of Five terms – Test of Convergence- Comparison test – Integral test- Comparison test – Integral test- Comparison test – Integral test- D'Alemberts Ratio test ,D'Alemberts Ratio test, Raabe's root test. - Convergent of Exponential Series - Cauchy's Root test - Log test Log test - Alternating Series: Leibnitz test - Series of positive and Negative terms. - Absolute Convergence - Conditional Convergence

Learning Resources

1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010
5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	1. Dr.K.C.Sivakumar, IIT Madras, kcskumar@iitm.ac.in	1. Dr.A.Govindarajan, SRMIST
	2. Dr.Y V S S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	2. Dr. N. Balaji, SRMIST

Course Code	21MAB102T	Course Name	ADVANCED CALCULUS AND COMPLEX ANALYSIS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	determine the Double and triple Integral and apply then in problems in Science and Engineering
CLR-2:	gain knowledge in interpretation of vector differentiation and vector integration which relates line integral, Green's, Stoke's and Gauss divergent theorem
CLR-3:	identify the techniques of Laplace Transforms and inverse transform and extend them in the problems of Science and Engineering
CLR-4:	construct the analytic function, discuss conformal mapping and bilinear transformation in Engineering Problems
CLR-5:	evaluate complex integrals and power series using various theorems

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	apply multiple integrals in solving problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	analyze vector differentiation and vector integration and related theorems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	apply Laplace transform techniques in solving Engineering problems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	utilize complex integrals and power series in solving engineering problems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	apply multiple integrals in solving problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Integral Calculus — **12 Hour**

Evaluation of double integration Cartesian and plane polar coordinates - Evaluation of double integration of plane polar coordinates. Evaluation of double integral by changing of order of integration - Evaluation of double integral by changing of order of integration -Area as a double integral (Cartesian) - Area as a double integral (polar) - Triple integration in Cartesian coordinates -Conversion from Cartesian to polar in double integrals - Conversion from Cartesian to polar in double integrals -Triple integration in Cartesian coordinates -Area of triple Integral.

Unit-2 - Vector Calculus — **12 Hour**

Review of vectors in Two and Three dimensions - Gradient, divergence, - curl – Solenoidal - Irrotational fields - Vector identities -(without proof) – Directional derivatives - Line integrals - Surface integrals - Surface integrals - Volume Integrals - Green's theorem (without proof), Green's theorem (without proof), - Gauss divergence theorem (without proof), verification -Gauss divergence theorem (without proof) applications to cubes. - Gauss divergence theorem (without proof applications to parallelepiped. -Stoke's theorems (without proof) – Verification Stoke's theorems (without proof) – Applications to cubes - Stoke's theorems (without proof) – Applications to parallelepiped only.

Unit-3 - Laplace Transform — **12 Hour**

Laplace Transforms of standard functions -Transforms properties - Transforms of Derivatives and Integrals - Transform of derivatives and integrals - Initial value theorems (without proof) and verification for some problems - Final value theorems (without proof) and verification for some problems - Inverse Laplace transforms using partial fractions - Inverse Laplace transforms sing Partial fractions -Inverse Laplace transforms section shifting theorem - LT using Convolution theorem -problems only - LT using Convolution theorem -problems only -ILT using Convolution theorem -problems only -Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficient only -Solution of Integral equation and integral equation involving convolution type

Unit-4 - Analytic Functions — **12 Hour**

Definition of Analytic Function- Cauchy Riemann equations - Cauchy Riemann equations -Properties of analytic function functions -Determination of analytic function using – Milne-Thomson's method - Conformal mappings: magnification -Conformal mappings: rotation Conformal mappings: inversion - Conformal mappings: inversion -Conformal mappings: reflection - Conformal mappings: reflection bilinear transformation - Cauchy's integral theorem (without proof) -Cauchy's integral theorem applications

Unit-5 - Complex Integration — **12 Hour**

Cauchy's integral formulae- Problems-Taylor's expansions with simple problems -Taylor's expansions with simple problems - Laurent's expansions with simple problems- Singularities -Types of Poles and Residues - Cauchy's residue theorem (without proof) - Contour integration: Unit circle. -Contour integration: Unit circle. -Contour integration: semicircular contour. -Contour integration: semicircular contour.

Learning Resources

1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010
5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	1. Dr.K.C.Sivakumar, IIT Madras, kcskumar@iitm.ac.in	1. Dr.A.Govindarajan, SRMIST
	2. Dr.Y V S S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	2. Dr. N. Balaji, SRMIST

Course Code	21PYB101J	Course Name	PHYSICS: ELECTROMAGNETIC THEORY, QUANTUM MECHANICS, WAVES AND OPTICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	2	5

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	identify the applications of electric field on materials
CLR-2:	identify the applications of magnetic field on materials
CLR-3:	identify the significance of quantum theory
CLR-4:	create insights to the concepts of optical effects
CLR-5:	analyze the working principle of lasers and optical fibers

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	express the significance of electrostatic fields	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	analyze electromagnetic induction	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	apply quantum mechanics to basic physical problems	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	apply ray propagation and optical effects	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	understand the types of lasers, structure and propagation properties of optical fiber and analyse its applications	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Electromagnetism and Dielectrics — **18 Hour**

Electromagnetism- Introduction- Del, divergence, curl and gradient operations in vector calculus-Gauss divergence and Stoke's theorem-Electric field and electrostatic potential for a charge distribution-Gauss' law and its applications-Laplace's equations for electrostatic potential-Poisson's equations for electrostatic potential- Concepts of electric current-Continuity equation-Laws of magnetism-Faraday's law, Ampere's law-Maxwell's equations-Maxwell's equations in free space- Characteristics impedance - Polarizations, permeability and dielectric constant-Polar and non-polar dielectrics-Types of polarization-Frequency and temperature dependence

Practice: 1. Determination of Internal Resistance of the given cell – Potentiometer, 2. Determine dielectric constant of the sample

Unit-2 - Magnetic Materials — **18 Hour**

Magnetization, permeability and susceptibility-Classification of magnetic materials-Ferromagnetism-Concepts of ferromagnetic domains-Hard and soft magnetic materials-Energy product--Ferrimagnetic materials-Ferrites-regular spinel and inverse spinel-Magnetic bubbles-Magnetic thin films-Spintronics-GMR-TMR-CMR-Garnets-Magnetoplumbites-Multiferroic materials-Applications of multiferroic materials

Practice: 1. Calibrate Ammeter using Potentiometer, 2. Calibrate Voltmeter using Potentiometer, 3.Determine magnetic susceptibility-Quincke's method

Unit-3 - Quantum Mechanics — **18 Hour**

Introduction to Quantum mechanics- Black body radiation, Concept of Photon-Photoelectric effect, Compton effect- Explanation of wave nature of particles-de Broglie hypothesis for matter waves-Heisenberg's uncertainty principle-Application of uncertainty principle- -Born interpretation of wave function-Verification of matter wave -Physical significance of wavefunction-Time independent Schrödinger's wave equation-Time dependent Schrödinger's wave equation-Particle in a 1 D box-Normalizations-Concept of harmonic oscillator-Quantum harmonic oscillator

Practice: 1. Determine Planck's constant, 2. Study of I-V characteristics of a light dependent resistor (LDR)

Unit-4 - Wave Optics — **18 Hour**

Introduction to interference-Introduction to diffraction-Fresnel diffraction-Fraunhofer diffraction-Fraunhofer diffraction at single slit-Fraunhofer diffraction at double slit-Fraunhofer diffraction at multiple slit-Diffraction grating-Characteristics of diffraction grating-Applications of diffraction grating-Polarization by reflection-Brewster's angle-Polarization by refraction-Malu's Law-Polarization by double refraction-Nicol Prism- Ordinary and Extraordinary Rays-Optical activity-Quarter and Half Waveplate- Circular polarization - Elliptical polarization

Practice: 1. Determine wavelength of monochromatic light Newton's ring, 2. Determine particle size using laser, 3.Determine Wavelength- diffraction grating

Unit-5 - Lasers and Fiber Optics — **18 Hour**

Absorption and emission processes-two level-Einstein's theory of matter radiation A and B coefficients-Characteristics of laser beams-Amplification of light by population inversion-Threshold population inversion-Essential components of laser system and pumping mechanisms-Nd: YAG laser-Semiconductor laser-CO2 laser:-Application of laser – Holography-Optical fiber-physical structure-Total internal reflection-Numerical aperture-Acceptance angle-Losses associated with optical fibers-Classification of optical fibers-Optical fiber communications system-Optical sensors

Practice: 1. Determine laser parameters – divergence and wavelength for a given laser source, 2. Study of attenuation and propagation characteristic-optical fiber Mini project

Learning Resources	
	1. David Jeffery Griffiths, Introduction to Electrodynamics, Revised edition, Pearson, 2013 2. AjoyGhatak, Optics, Tata McGraw Hill Education, 5th edition, 2012 3. David Halliday, Fundamentals of Physics, 7th edition, John Wiley & Sons Australia, Ltd, 2004 4. Eisberg and Resnick, Quantum Physics: Of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition, 1985

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	1. Prof .C. Vijayan, IITM, Chennai, cvijayan@iitm.ac.in	1. Dr. C. Preferencial Kala, SRMIST
	2. Prof. S. Balakumar, Univ of Madras, balakumar@unom.ac.in	2. Dr. M. Alagiri, SRMIST

Course Code	21CYB101J	Course Name	CHEMISTRY	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	2	5

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	exploit the periodic properties of elements for bulk property manipulation towards technological advancement and interpret water quality parameters
CLR-2:	address concepts related to electrochemistry, such as corrosion, using thermodynamic principles and measure the acidic strength and redox potentials of aqueous solution
CLR-3:	employ various organic reactions towards the design of fine chemical and drug molecules for industries and measure the acidic strength and conductance of aqueous solution
CLR-4:	brief outline, reaction types and applications of polymers and determine average molecular weight of the polymer
CLR-5:	properties, surface characterization and applications of advanced engineering materials and measure the acidic strength of aqueous solution

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	rationalize bulk properties using periodic properties of elements, evaluate water quality parameters like hardness and alkalinity	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	utilize the concepts of thermodynamics in understanding thermodynamically driven chemical reactions, determine acidic strength and redox potentials of aqueous solution	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	perceive the importance of stereochemistry in synthesizing organic molecules applied in pharmaceutical industries, determine acidic strength and conductance of aqueous solution	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	utilize the concepts of polymer processing for various technological applications, determine average molecular weight of the polymer	3	-	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	analyze the importance of advanced processing techniques towards engineering applications and measure the acidic strength of aqueous solution	3	-	3	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Periodic properties — **18 Hour**

Coordination numbers and geometries - Crystal field theory - Octahedral & Tetrahedral complexes - Optical & magnetic properties of transition metal complexes - Isomerism in transitional metal compounds - Effective nuclear charge, penetration of orbitals - variations of orbital energies of atoms in the periodic table - Electronic configurations, atomic and ionic sizes - ionization energies, electron affinity and electronegativity - Hard soft acids and bases

Practice: 1. Determination of the amount of sodium carbonate and sodium hydroxide in a mixture by titration, 2. Determination of hardness (Ca^{2+}) of water using EDTA – Complexometry method.

Unit-2 - Use of free energy in chemical equilibria — **18 Hour**

Thermodynamic functions: Energy, Entropy and free energy - Estimation of entropy & free energies - Free energy and emf. Cell potentials - The Nernst equation and applications - Acid base, oxidation reduction - Solubility equilibria - Corrosion - Free energy of a corrosion reaction - Pourbaix diagram Salient Features and phase diagram for Iron

Practice: 1. Determination of strength of an acid by Conductometry, 2. Determination of ferrous ion using potassium dichromate by Potentiometric titration

Unit-3 - Stereochemistry and Organic Reactions — **18 Hour**

Representations of 3 dimensional structures - structural isomers and stereoisomers - configurations and symmetry and chirality - enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis - Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings - Synthesis of a commonly used drug molecule.

Practice: 1. Estimation of amount of chloride content of a water sample, 2. Determination of the strength of a mixture of acetic acid and hydrochloric acid by Conductometry

Unit-4 - Polymers — **18 Hour**

Introduction to concept of macromolecules - Tacticity - Classification of Polymers - Thermoplastics, Thermosets and Elastomers - Types of Polymerization - Important addition and condensation polymers – synthesis and properties – Polypropylene, polystyrene, PVC, Teflon, Nylon, PET, Polyurethane and Synthetic rubber, Conducting polymers – introduction, types – n and p doping, examples (polyacetylene and P3HT), applications

Practice: 1. Determination of molecular weight of polymer by viscosity average method.

Unit-5 - Advanced Engineering Materials — **18 Hour**

Mechanical properties of solid – stress-strain relationship - Tensile strength, Hardness, Fatigue, Impact strength, Creep – Composite materials - introduction - Types of composites - Fibre Reinforced Composites. Particle Reinforced Composites. Metal Matrix Composites. Ceramic Matrix Composites. Examples and applications. Surface Characterisation techniques - XRD and XPS.

Practice: 1. Determination of strength of an acid using pH meter.

Learning Resources

1. B. H. Mahan, R. J. Meyers, University Chemistry, 4th ed., Pearson publishers, 2009.
2. M. J. Sienko, R. A. Plane, Chemistry: Principles and Applications, 3rd ed., McGraw-Hill publishers, 1980
3. B. L. Tembe, Kamaluddin, M. S. Krishnan, Engineering Chemistry (NPTEL Web-book) http://nptel.ac.in/downloads/122101001/
4. Peter W. Atkins, Julio de Paula, James Keeler, Physical Chemistry, 11th ed., Oxford publishers, 2021
5. K. P. C. Vollhardt, N. E. Schore, Organic Chemistry: Structure and Function 7thed., Freeman, 2014
6. W. D. Callister, D. G. Rethwisch, Materials Science and Engineering: An Introduction, 8th ed., Wiley, 2009
7. J. C. Kuriacose, J. Rajaram, Chemistry in Engineering and Technology, Tata McGraw-Hill Education, 1984

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA) – Formative CLA-1 Average of unit test (45%)		Continuous Learning Assessment (CLA) – Life-Long Learning CLA-2 (15%)		Summative Final Examination (40% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	-	20%	10%	-
Level 2	Understand	30%	-	-	20%	30%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in	1. Prof. M. Arthanareeswari, SRMIST
2. Dr. Sudarshan Mahapatra, General Manager, Encube Ethicals Pvt. Ltd., Mumbai, sudarshan.m@encubeethicals.com	2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in	2. Dr. K. Ananthanarayanan, SRMIST

Course Code	21CYM101T	Course Name	ENVIRONMENTAL SCIENCE	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	acquire knowledge on various causes, effects and control measures of environmental air and water pollution
CLR-2:	acquire knowledge on various causes, effects and control measures of soil, thermal and radiation pollution
CLR-3:	acquire knowledge on various process involved in the treatment of wastewater
CLR-4:	identify sources, disposal and treatment methods of solid waste management
CLR-5:	identify sources, disposal and treatment methods of biomedical waste management

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	analyze the sources, effects and control measures of environmental air pollution	3	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	analyze causes, effects and control measures ,of soil, thermal and radiation pollution	3	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	explain the processes involved in waste water treatment and investigate the cause of a local polluted site	-	3	-	-	-	-	3	-	3	-	-	-	-	-	-
CO-4:	illustrate the treatment methods involved in solid waste management and investigate the impact in local areas	-	3	-	-	-	-	3	-	3	-	-	-	-	-	-
CO-5:	illustrate the treatment methods involved in biomedical waste management and investigate the impact in local areas	-	3	-	-	-	-	3	-	3	-	-	-	-	-	-

Unit-1 - Environmental Segments, Air and Water Pollution — **3 Hour**

Environmental segments Structure of atmosphere - Composition of atmosphere - Air Pollution Sources - Effects – acid rain, ozone layer depletion and greenhouse effect Control measures of air pollution - Sources, effects and control measures of Water pollution

Unit-2 - Soil, Thermal and Radiation Pollution — **3 Hour**

Determination of BOD and COD - Determination of TDS and trace metals - Sources, effects and control measures of Soil pollution - Sources, effects and control measures of Thermal pollution - Sources and effects of Radiation pollution - Control measures of Radiation pollution

Unit-3 - Waste Water Treatment — **3 Hour**

Waste water treatment - Introduction - Primary treatment - Secondary treatment - Tertiary treatment - Activity: Visit to a local polluted Urban/Rural/Industrial/Agricultural site

Unit-4 - Solid Waste Management — **3 Hour**

Solid waste management - Types – Effects - Process of waste management - Disposal methods, Open dumping, Engineered land filling, Composting, Incineration - Activity: Monitoring solid waste management in local areas

Unit-5 - Biomedical Waste Management — **3 Hour**

Biomedical Waste Management- Definition and Effects - Categories of biomedical waste - Process of biomedical waste management - Treatment and disposal methods - Activity: Visit a hospital to understand the biomedical waste management.

Learning Resources	
1.	Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd ed., UGC
2.	Kamaraj. P, Arthanareeswari. M, Environmental Science–Challenges and Changes, 6th ed., Sudhandhira Publications, 2013
3.	R.Jeyalakshmi, Principles of Environmental Science, Devi publications, 2nd ed., 2008.
4.	Helen P Kavitha, Principles of Environmental Science, Shine Publications and Distributors, 1st Edition, 2013

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (40%)		Life long learning CLA-2 (40%)		Summative (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	-	-
Level 2	Understand	20%	-	20%	-	20%	-	-	-
Level 3	Apply	30%	-	30%	-	10%	-	-	-
Level 4	Analyze	30%	-	30%	-	30%	-	-	-
Level 5	Evaluate	-	-	-	-	20%	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in	1. Prof. M. Arthanareeswari, SRMIST
2. Dr. Sudarshan Mahapatra, General Manager, Encube Ethicals Pvt. Ltd., Mumbai, sudarshan.m@encubeethicals.com	2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in	2. Dr. K. K. R. Datta, SRMIST

Course Code	21CSS101J	Course Name	PROGRAMMING FOR PROBLEM SOLVING	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	think and evolve with a logic to construct an algorithm and pseudocode that can be converted into a program
CLR-2:	utilize the appropriate operators and control statements to solve engineering problems
CLR-3:	store and retrieve data in a single and multidimensional array
CLR-4:	create custom designed functions to perform repetitive tasks in any application
CLR-5:	create basic Abstract Data Types with python

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	solve problems through computer programming Express the basic data types and variables in C	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-2:	use appropriate data types in simple data processing applications, and to create programs using the concept of arrays	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-3:	create string processing applications with single and multi-dimensional arrays	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-4:	create user defined functions with required operations and to implement pointers in applications with dynamic memory requirements	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-5:	create programs using the python data types, loops, control statements for problem solving	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-

Unit-1 - 15 Hour

Evolution of Programming & Languages - Problem solving through programming - Writing algorithms & Pseudo code - Single line and multiline comments - Introduction to C: Structure of the C program - Input and output statements. Variables and identifiers, Constants, Keywords - Values, Names, Scope, Binding, Storage Classes - Numeric Data types: integer, floating point Non-Numeric Data types: char and string - L value and R value in expression, Increment and decrement operator - Comma, Arrow and Assignment operator, Bitwise and Size-of operator - Arithmetic, Relational and logical Operators - Condition Operators, Operator Precedence - Expressions with pre / post increment operator

Unit-2 - 15 Hour

Conditional Control -Statements :Simple if, if...else - Conditional Statements : else if and nested if - Conditional Statements : Switch case - Un-conditional Control Statements : break, continue, goto - Looping Control Statements: for, while, do.while - Looping Control Statements: nested for, nested while - Introduction to Arrays -One Dimensional (1D) Array Declaration and initialization - Accessing, Indexing and operations with 1D Arrays - Array Programs – 1D - Initializing and Accessing 2D Array, Array Programs – 2D - Pointer and address-of operators -Pointer Declaration and dereferencing, Void Pointers, Null pointers Pointer based Array manipulation

Unit-3 - 15 Hour

String Basics - String Declaration and Initialization - String Functions: gets(), puts(), getchar(),putchar(), printf() - Built-inString Functions: atoi, strlen, strcat, strcmp -String Functions: sprint, sscanf, strrev, strcpy, strstr, strtok - Operations on Strings - Function prototype declaration, function definition - Actual and formal parameters - Function with and without Arguments - Function with and without return values - Call by Value, Call by Reference - Passing Array to Function - Passing Array elements to Function - Function Pointers.

Unit-4 - 15 Hour

Python: Introduction to Python - Introduction to Google Colab - Basic Data Types: Integers, Floating Points, Boolean types - Working with String functions - Working with Input, Output functions - Python-Single and Multi-line Comments/ Error Handling - Conditional & Looping Statements : If, for, while statements - Working with List structures - Working with Tuples data structures - Working with Sets - Working with Dictionaries - Introduction to Python Libraries - Introduction to Numpy - High Dimensional Arrays

Unit-5 - 15 Hour

Creating NumPy Array -Numpy Indexing - Numpy Array attributes - Slicing using Numpy - Descriptive Statistics in Numpy: Percentile - Variance in Numpy -Introduction to Pandas - Creating Series Objects, Data Frame Objects - Simple Operations with Data frames - Querying from Data Frames -Applying Functions to Data frames - Comparison between Numpy and Pandas - Speed Testing between Numpy and Pandas - Other Python Libraries

Practice

Practice 1: Input, Output Statements, Variables	Practice 6: Arrays with Pointers	Practice 11: Python data structures
Practice 2: Data types & Operators-I	Practice 7: Strings	Practice 12: Arrays in Python
Practice 3: Data types & Operators-II	Practice 8: Functions	Practice 13: Operations with Numpy
Practice 4: Control Statements (Branching, Looping)	Practice 9 : Arrays and Functions	Practice 14: Operations with Pandas
Practice 5: Arrays	Practice 10: Input, Output in Python	Practice 15: case study: Data science with Numpy, Pandas

Learning Resources

1. Programming in C, E.Balagurusamy,Mc Graw Hill, Eighth Edition.2019. [chapters 1 to 6 & 8 To 11]
2. Head First C: A Brain-Friendly Guide, By David Griffiths, Dawn Griffiths,Oreilly. [Chapters 2 to 4]
3. Let Us C, Fifth Edition, Yashavant P. Kanetkar,BPB publications.[Chapters 1 to 6, 8 to 9]
4. Problem Solving & Programming Concepts, Maureen Sprankle, Jim Hubbard, Prentice Hall, Ninth Edition. [Chapters 1 to 7]
5. https://www.geeksforgeeks.org/c-programming-language/
6. Python Datascience Handbook, Oreilly.Jake VanderPlas, 2017.[Chapters 2 &3]
7. Python for Beginners, Timothy C.Needham, 2019. [Chapters 1 to 4]
8. https://www.tutorialspoint.com/python/index.htm
9. 10. https://www.w3schools.com/python/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	15%	15%	-
Level 2	Understand	20%	-	-	15%	15%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	15%	15%	-
Level 6	Create	10%	-	-	15%	15%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	1. Prof. Janakiram D, IIT Madras, djram@iitm.ac.in	1. Dr. E.Poovammal, SRMIST
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com		2. Dr. B. Amutha, SRMIST
		3. Dr. Rajeev Sukumaran, SRMIST

Course Code	21EES101T	Course Name	ELECTRICAL AND ELECTRONICS ENGINEERING	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	outline the concepts and theorem of DC and AC electric circuits
CLR-2:	gain knowledge on analog and digital electronics
CLR-3:	familiarize the concept of DC / AC machines and drives
CLR-4:	illustrate the working of different sensors and transducers
CLR-5:	acquire the knowledge on Power Engineering

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	examine the fundamentals of DC and AC electric circuits	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply the analog and digital electronics to real time problem	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	describe the working principle of machines and interpret its application to drives	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	summarize the working of various sensors and transducers	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	disseminate the latest trends in power engineering and its application to electric vehicle	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Electric Circuits **12 Hour**

Introduction to basic terminologies in DC circuit, Kirchhoff's Current law, Kirchhoff's21EE Voltage law, Mesh Current Analysis, Nodal Voltage Analysis, Thevenin's Theorem, Maximum power transfer Theorem, Superposition Theorem. Basic terminologies of AC - RMS and Average value of halfwave and Full wave alternating quantity, Fundamentals of single-phase AC circuits- Analysis of R-L, R-C, R-L-C series circuits- Fundamentals of three phase AC system, Three-Phase Winding Connections, Relationship of Line and Phase Voltages, and Currents in a Delta and Star-connected System.

***Practice on** Theorems, Halfwave, Full wave bridge rectifier circuits*

Unit-2 - Electronics **12 Hour**

Overview of Semiconductors, Diodes and Transistors, Introduction to JFET and MOSFET, Construction and working of power devices-SCR, BJT, MOSFET, IGBT -Switching Characteristics of SCR- Types of power converters- Natural and forced commutation, Linear voltage Regulator, SMPS. Realize the logic expression using basic logic gates, Combinational logic design-Sum of Product form (SOP) and Product of Sum (POS) form, Min term and Max term, Karnaugh Map (K-Map) representation of logical functions, Two variables K-Map, Three variables K-Map, Four variables K-Map. Introduction to FPGA.

***Practice on** realization of logical expression, combinational circuits, PCB design, soldering and testing*

Unit-3 - Machines and Drives **12 Hour**

Construction and working principle of DC machines- Construction and Working principle of a single-phase Transformer- Construction and working of three phase Induction motor, BLDC motor, PMSM, Stepper and Servo motor. Introduction to Electrical Drives-Block diagram explanation of chopper fed DC drives, Selection of drives for real time applications (cranes/EV/ Pumping applications)

***Practice on** chopper applications, Demo on DC& AC machines*

Unit-4 - Transducers and Sensors **12 Hour**

Basic principles and classification of Instruments- Moving Coil instruments, Moving Iron instruments, Digital Multi meter, Digital storage Oscilloscope. Transducer- Classification- Capacitive and Inductive transducers, Linear Variable Differential Transformer (LVDT), Thermistors, Thermocouple, Piezoelectric transducer, Photoelectric transducer, Hall effect transducers. Introduction to Opto-electronics Devices, Light Dependent Resistor (LDR), Photodiodes, Phototransistors, Photovoltaic cells (solar cells), Optocouplers, Liquid crystal display, Proximity sensor, IR sensor, Pressure sensor, Introduction to Bio sensor, Sensors for smartbuilding.

***Practice on** capacitive and inductive transducer, thermistor and LVDT using virtual lab*

Unit-5 - Power Engineering **12 Hour**

Electrical supply system- simple layout of Generation, transmission and Distribution of power, Typical AC and DC power supply schemes, overview on substation equipment with key diagram of 11kV/400 V indoor substation- Introduction to smart grid. Safety Measures in Electrical systems- Basic Principle and importance of Ear thing- precautions for Electric shock- safety devices .Introduction to renewable energy resources: Solar Photovoltaic -Introduction to energy storage systems-overview of battery, Fuel cell technologies- HEVs, PHEVs and EVs – EV Charging station

***Practice on** different types of wiring circuits and safety measures*

Learning Resources

1. Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, Hughes Electrical and ElectronicTechnology, Pearson Education, 12th ed., 2016
2. S. K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011
3. R. Muthusubramanian, S. Salivahanan, Basic Electrical and Electronics Engineering, Tata McGraw-Hill, 2012
4. Charles Alexander, Matthew Sadiku, Fundamentals of electrical circuits, McGraw-Hill Education;5th ed., 2012
5. Morris M. Mano, Digital Design, 3rd ed.,Pearson Education, 2011
6. Ernest Doebelin, Dhanesh Manik, Measurement systems, Fourth Edition, McGraw Hill, July 2017.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss, Industries Pvt Ltd., paramsathya@yahoo.com	1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in	1. Dr. A.Rathinam, SRMIST
2. Dr.Bhaskar Sahu, Schneider Electric Ltd, bhaskar.Sahu@se.com	2. Dr. S.Chandramohan, CEG, c_dramo@annauniv.edu	2. Dr. P.Eswaran, SRMIST

Course Code	21MES101L	Course Name	BASIC CIVIL AND MECHANICAL WORKSHOP	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil and Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	practice machining and glass cutting shop floor trade
CLR-2:	practice arc & gas welding, and fitting and make new assemblies according to various dimensions and tolerances
CLR-3:	practice basic carpentry joints and sheet metal shop floor practices
CLR-4:	practice casting, moulding, & smithy trades
CLR-5:	practice and make G.I & P.V.C. plumbing trade

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	machine in a lathe Drill using drilling machines Cut glass Create new components according to specifications	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-2:	weld joints using arc & gas welding Fit pipes and fixtures Make new assembly for given dimensions, and tolerances	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-3:	practice basic carpentry joints used in house hold furniture items, and sheet metal items used shop floor practices	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-4:	practice casting, moulding, & smithy trades	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-5:	make G.I & P.V.C pipe line connections used in the plumbing trade	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-

Unit-1 - Machining Process — **12 Hour**

Machining, Drilling, Tapping, Glass cutting - Machining: Basics of Machining Processes Equipment's - Tools and demonstration of machining to produce models - Simple turning of cylindrical surface on MS rod using lathe machine tool - Simple turning of cylindrical surface on MS rod using lathe machine tool - Basics of drilling and tapping processes, Equipment's, tools - Demonstration of drilling and tapping to produce models. - Generate hole on a metal piece - Generate internal thread on a metal piece. Basics of Glass cutting processes, - Equipment's.- Tools and demonstration of producing models - Make glass panels for boxes

Unit-2 - Metal Joining Process — **12 Hour**

Welding (Arc and Gas) and fitting - Basics of Metal Arc welding operations, Equipment's - Tools and demonstration of producing models - Butt joint of two metal plates using arc welding process - Lap joint of two metal plates overlapping on one another using arc welding process. - Basics of gas welding operations, Equipment's, - Tools and demonstration of producing models - MIG welding of metal plates - TIG welding of metal plates - Basics of fitting practice, tools and method - of producing models - Tools and demonstration of producing models - Step fitting of two metal plates using fitting tools

Unit-3 - Carpentry and Sheet Metal — **12 Hour**

Basics of Carpentry operations, Equipment's - Tools and demonstration of producing models - Cross halving joint of two wooden pieces at perpendicular direction - To make duster from wooden piece using carpentry tools.- Basics of Sheet metal operations, Equipment's - Tools and demonstration of producing sheet metal models - To make Rectangular shaped tray using GI sheet - To make bigger size scoop using GI sheet. - Basics of different geometrical shapes in Sheet metal operations - Equipment's, tools and demonstration of producing models - To make geometrical shape like frustum, Cone and Prism using G.I sheet

Unit-4 - Foundry and Smithy — **12 Hour**

Casting, moulding and smithy - Basics of Casting, processes, Equipment's - Tools and demonstration of producing models - To make the mould using stepped flange - To make the mould using stepped flange - Basics of injection moulding and processes, Equipment's, - Tools and demonstration of producing models - To make plastic models using injection moulding of simple part - To make plastic models using injection moulding of simple part - Basics of Smithy processes, Equipment's, - Tools and demonstration of producing models - To forge chisel from MS rod using black smithy

Unit-5 - Plumbing — **12 Hour**

Plumbing (G.I and P.V.C) - Basics of Plumbing practices for G.I and P.V.C. - Tools and demonstration of producing models - Plumbing of bathroom/ kitchen fittings using G.I. fittings - Plumbing of bathroom/ kitchen fittings using G.I. fittings - PVC Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Tools and demonstration of producing models - Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Basics of Plumbing practices for G.I pipe - lines and fittings for pumps and machines - Equipment's, tools and demonstration of producing models. - Plumbing of pipe lines and fitting for Pumps using G.I fittings

Learning Resources

1. Jeyachandran K., Natarajan S. & Balasubramanian S., A Primer on Engineering Practices Laboratory, Anuradha Publications, 2007
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., Engineering Practices Lab Manual, Vikas Publishing House Pvt.Ltd, 2006.
3. Bawa H.S., Workshop Practice, Tata McGraw, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., Workshop Practice, Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., Manual on Workshop Practice, Scitech Publications, 1999.
6. Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjhar Roy S.K., Elements of Workshop Technology, Vol.I & Vol.II 2010, Media promoters and publishers private limited, Mumbai.
7. Rao P.N., Manufacturing Technology, Vol. I & Vol. II, Tata McGrawHill, 2017.
8. Gopal T.V, Kumar. T, Murali. G, A first course on workshop practice – Theory, Practice and Work Book, Suma Publications, Chennai, 2005.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-		-	-
Level 6	Create	-	-	-			-	-	-
	Total	100 %		100 %		100%		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Kalimuthu, ISRO, Trivandrum	1. Dr. Ramkumar P, IIT Madras, ramkumar@iitm.ac.in	1. Mr. A. Thirugnanam, SRMIST
2. Dr. A. Velayutham, DRDO, Chennai	2. Dr. Sourav Rakshit, IIT Madras, srakshit@iitm.ac.in	2. Dr. S. Prabhu, SRMIST

Course Code	21MES102L	Course Name	ENGINEERING GRAPHICS AND DESIGN*	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	utilize engineering graphic fundamentals and apply the same to draw engineering curves and projection of objects
CLR-2:	draw the projection of solids like prisms, cylinder, pyramids and cone
CLR-3:	model the projection of combined solids, section of solids
CLR-4:	create the development of surfaces and construction of building drawing
CLR-5:	develop the assemblies of 3D parts and create 2D drawings from the assembly

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	construct the geometrical curves, projection of points, lines and planes	1	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-2:	develop the orthographic projection of solids	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-3:	construct the projection of combination and section of solids	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-4:	construct the development of surfaces and projection of buildings	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-5:	develop solid modelling, assembly of parts and extraction of 2D drawings	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-

Unit-1 – Projection — **12 Hour**

Principles, Standards, Conventions - Angle Projection, Symbols, Dimensions - 2D Geometric Constructions - 2D Geometric Constructions - Conic Curves ellipse by eccentricity method - Conic Curves ellipse by eccentricity method - Cycloids, Epicycloids – Hypocycloid - Involute of a Square, Circle – Spirals -Introduction to perspective projection with terminologies and concepts - Orthographic Multiview and isometric projection - Perspective projection of a point, line - Perspective projection of a planes, solids - Orthographic Multiview of point, line - Orthographic Multiview of planes, solids -Isometric projection of a point, line - Isometric projection of planes, solids - Isometric to orthographic Multiview sketching - Orthographic Multiview to isometric sketch - Orthographic Multiview projection of lines inclined to both planes - Orthographic Multiview projection of planes inclined to planes, auxiliary projection - Projection of lines inclined to both the planes - true length, true inclinations, traces of lines - Projection of lines inclined to both the planes - true length, true inclinations, traces of lines - Finding shortest distance between a point and a plane - Shortest distance between two lines -shortest distance between point and plane - shortest distance between point and plane

Unit-2 - Projection of Solids using CAD Software — **12 Hour**

Introducing CAD Software, layers, - dimensions, tolerance, annotations - Create, modify, customize, print using CAD - Demo: Menu, Toolbars, Drawing Area, Dialog box, windows, Shortcut menus - Command Line, Status Bar, Different zoom methods, Create, Select, Erase objects - Draw straight lines, rectangle, polar, absolute, relative - Orthographic constraints, Ortho ON, snap to objects manually, automatically - drawing lines, arcs, circles, polygons, create, edit, use layers, extend lines - Dimensioning objects, annotations - Demo: drawing page, print, units/ scale/ limits settings, standards for dimensioning - ISO, ANSI Std. dimensioning, tolerance - Projection of solid prisms and cylinders - inclined to both the planes - change of position method, reference line - method / auxiliary projections, - Projection of solid prisms and cylinders - inclined to both the planes - Change of position method - Projection of solid prisms and cylinders inclined to both the planes. Reference line method - Auxiliary projections - Auxiliary projections - Viewing isometric and perspective views, shaded, wire-frame models - Oblique prismatic solids and its projections - Projection of solid pyramids and cones inclined to both the planes - change of position method and reference line method / auxiliary projections, - Projection of solid pyramids and cones inclined to both the planes - Change of position method - Projection of solid pyramids and cones inclined to both the planes - Change of reference line method - Auxiliary projections - Auxiliary projections - Viewing isometric and perspective views, shaded, wire-frame models - Oblique pyramidal solids and projections

Unit-3 - Projections of Combination of Solids — **12 Hour**

Combinations of solids, Constructive Solid Geometry(CSG), Boolean operations - Creating combination of solids, isometric, perspective views, shaded, wire-frame - Constructive Solid Geometry, Boolean operations, Creating combination of solids - isometric, perspective, shaded, wire-frame - Constructive Solid Geometry, Boolean operations, Creating combination of solids - isometric, perspective, shaded, wire-frame -Constructive Solid Geometry, Boolean operations, Creating combination of solids - isometric, perspective, shaded, wire-frame - Section of right regular solid with axis perpendicular to one principal planes and cutting plane perpendicular to any one - principle plane true shape of the section - Section of right regular solid with axis perpendicular to one principal planes and - cutting plane perpendicular to any one principle plane true shape of the section - Section of right regular solid with axis perpendicular to one principal planes and cutting plane perpendicular to any one - principle plane true shape of the section - Section of solids with axis inclined to both the planes and cutting plane perpendicular to any one principal plane only. - Sectional plan elevation, and sectional side-view of Building/ dwelling, include - windows, doors, fixtures, etc. - Building/ Dwelling drawing, Terminology, conventions, sectional plan and side-view of Building/ dwelling, include windows, -doors, fixtures, Sectional plan elevation, and sectional side-view of Building/ dwelling, include windows, doors, fixtures, etc. - Sectional plan elevation, and sectional side-view of Building/ dwelling, include windows, doors, fixtures, etc.-Sectional plan elevation, and sectional side-view of Building/ dwelling, include - windows, doors, fixtures, etc.- Sectional plan elevation, and sectional side-view of Building/ dwelling, include windows, doors, fixtures, etc.

Unit-4 - Part Modeling and Drawing — **12 Hour**

3D modelling, parametric, non- parametric, parts of CSG, surface, wireframe, shaded-Rendered models, background, shadows, multi-view, isometric, perspective views - 3D modelling, parametric, non- parametric, parts of CSG, surface, wireframe, shaded - Rendered models, background, shadows, multi-view, isometric, perspective views -Viewing models in multi-view, isometric and perspective views - Viewing models in multi-view, isometric, and perspective views - Modelling industrial part drawings - Modelling industrial part drawings -Design new components as a team - Design new components as a team - 3D Part to 2D Drawings geometric - dimensioning and tolerance annotations - generating 2D from 3D models, printing drawings, generating sectional views - Geometric dimensioning and tolerance annotations - Geometric dimensioning and tolerance annotations - Generating 2D drawings from 3D models - Generating 2D drawings from 3D models Generating sectional views - Generating sectional views - Printing drawings to printer or as .pdf - Printing drawings to printer or as .pdf - Development of surfaces: un-cut, & cut right / oblique regular solids Simple position with cutting planes perpendicular to any one principal plane - Development of surfaces: un-cut, & cut right / oblique regular solids - Simple position with cutting planes perpendicular to any one principal plane - Development of surfaces: un-cut, & cut right / oblique regular solids - Simple position with cutting planes perpendicular to any one principal plane - Design of real time surface-development Design of real time surface-development - Design of real time surface-development - Design of real time surface-development

Unit-5 - Assembly Modeling and Drawing — **12 Hour**

Part/ component model creation for assembly.-Study of various widely used assembly of parts like flanged joint, universal joint etc. -Creation of parametric parts for assembly - non- parametric parts for assembly - Creation of parametric parts for assembly - non- parametric parts for assembly - Creation of parametric parts for assembly -non- parametric parts for assembly - Creation of parametric parts for assembly - non-parametric parts for assembly - Simple assembly of parts,- associated part and assembly - Simple assembly of parts, - associated part and assembly - Simple assembly of parts, - associated part and assembly - Simple assembly of parts, -associated part and assembly - Simple assembly of parts,-associated part and assemblyAssembly Drawings: exploded view with assembly annotations part details -Printing assembly drawings to printer and as pdf -Exploded view with assembly annotations -part details -Exploded view with assembly annotations -part details -Exploded view with assembly annotations part details - Printing assembly drawings - Printing assembly drawings

Learning Resources

1. Bhatt, N.D., Engineering Drawing (First Angle Projection),53rd ed., Charotar Publishing House, 2017
2. Bethunc, J., Engineering Graphics with AutoCAD 2017, Pearson Education, 2016
3. Khristofor Artemyevich Arustamov, Problems in projective geometry, MIR Publishers, Moscow, 1972
4. Natarajan, K.V., A Text Book of Engineering Graphics, 21st Edition, Dhanalakshmi Pub., 2012
5. Shah. M. B.,Rana, B. C, Engineering Drawing, Pearson Education, Pvt. Ltd., 2005
6. Jeyapoovan. T., engineering drawing and Graphics using AutoCAD, Vikas Pub. House, 2015
7. Narayanan, K. L., Kannaiah, V., Engineering Graphics, Scitech Publications,2010
8. Luzzader, Warren J., Duff John M., Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Prentice Hall of India Pvt. Ltd., 2005.
9. Mohammad Dastbaz, Chris Gorse, Alice Moncaster (eds.), Building Information Modelling, Building Performance, Design and Smart Construction, Springer 2017
User Manual of Respective CAD Softwares

Course Code	21BTC101T	Course Name	BIOCHEMISTRY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	explain the structure and functions of biomolecules
CLR-2:	define the metabolism, bioenergetics and photosynthesis
CLR-3:	explain the carbohydrate metabolism and hormonal regulation
CLR-4:	acquire knowledge of the metabolism of proteins and amino acids
CLR-5:	explain mechanism of lipid metabolism and associated hormones

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	describe the structure and functions of biomolecules	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-2:	conclude the concepts of metabolism, bioenergetics and photosynthesis	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	explain the concepts in metabolism of carbohydrates and hormonal regulation	3	-	-	3	3	-	-	-	-	-	-	-	-	2	-
CO-4:	describe the metabolism of proteins and removal of nitrogen	3	3		3	-	-	-	-	-	-	-	-	-	-	2
CO-5:	summarize the lipid and nucleic acid metabolism	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to Biochemistry — **9 Hour**

History of Biochemistry, Chemical bonds, pH and Buffers. Introduction to Carbohydrates - Classification – Monosaccharaides, Oligosaccharides and Polysaccharides - structure and functions. Glycoproteins and lectins. Protein composition and structures – Introduction – structure, classification, functions. Amino acids – classification, structure and functions. Enzymes – Basic concepts and regulations. Lipids and Cell membrane – Introduction – classification, structure and functions. DNA and RNA - structure and functions

Unit-2 - Introduction to Metabolism, Bioenergetics and Photosynthesis — **9 Hour**

Metabolism – Basic concepts and design. Bioenergetics – Introduction - High energy compounds, Biological oxidation - Electron transport chain, Oxidative phospholyration, Chemiosmotic theory - Shuttle pathways – Glycerol phosphate Shuttle, Malate aspartate Shuttle. Photosynthesis - Light and Dark reactions.

Unit-3 - Carbohydrate Metabolism — **9 Hour**

Carbohydrate metabolism - Glycolysis - Citric acid cycle – Gluconeogenesis - Glycogen metabolism – Glycogenesis – Hormonal regulations - Muscle use of Glycogen - Blood glucose levels regulation by Insulin.

Unit-4 - Protein Turnover and Amino Acids Metabolism — **9 Hour**

Protein turnover – Introduction – Degraded to amino acids – Removal of Nitrogen - Regulation - Metabolism of amino acids – Transamination – Deamination - decarboxylation - Metabolism of ammonia - Urea cycle - Biosynthesis of amino acids – Feedback Inhibition Regulations.

Unit-5 - Fatty Acid and Nucleic Acids Metabolisms — **9 Hour**

Fatty acid metabolism – Introduction - Hormones signal the release of fatty acids from adipose tissue - Fatty acid oxidation - Ketone bodies & Ketogenesis - Biosynthesis of Fatty acids – Eicosanoids - Cholesterol Biosynthesis – Lipoproteins. Nucleic acid metabolism – Introduction – Biosynthesis and Degradation of Purine and Pyrimidine.

Learning Resources

1. JeremyM.Berg,JohnL.Tymoczko,GregoryJ.Gatto,LubertStryer,"Biochemistry",9thEdition,2019
2. Donald Voet, Judith G.Voet, Charlotte W. Pratt," Fundamentals of Biochemistry: Life at the Molecular Level", 5thEdition, JohnWiley &Sons Inc., 2016
3. U.Satyanarayanaand, U.Chakrapani, "Biochemistry", 4thEdition, ElsevierIndia, 2013.
4. DavidL.Nelson,MichaelM.Cox,"LehningerPrinciplesofBiochemistry",7th Edition, W.H.Freemen &Co.,2017

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15 %	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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